

DipHE transfer student hit by grant problem

by Sue Reid

One of the first graduates of the controversial Diploma in Higher Education may be forced to give up a place on a degree programme this autumn because of lack of funds.

Mr Michael Mason, who graduated from Bulmershe College of Higher Education this summer with a DipHE in environmental studies, joined Plymouth Polytechnic for a degree course but now he has discovered that he may not be eligible for full grant aid.

Plymouth Polytechnic will accept him for the second year of the BSc course in environmental sciences yet Hampshire County Council, his local education authority, has indicated that DipHE students are only eligible for a full mandatory grant if they transfer to the third year of a degree programme.

Mr Mason said: "Plymouth will only give me a year's exemption in lieu of my DipHE leaving me with two years to complete. They say there is not sufficient overlap between the two courses, despite the fact they are compatible."

He added: "Hampshire County Council will grant me financial assistance only for the third and final year of the degree. They regard the second year as a retake."

The Department of Education Science has warned DipHE students that mandatory grants will only be available to them for one further year of study. Students who transfer to a degree course and are excused one year are eligible but not for a second year of study.

Mr Mason is prepared to work his way through university. He has been working in a factory through-

out the summer and has already raised £400 towards his costs. "I really need about £1,000 for a full year. I have applied to local charities for help but unless I can find some more money I will not be able to join the course," he said.

Hampshire County Council is still considering his case. A spokesman said that further information was being sought from Bulmershe College and Plymouth Polytechnic. "We have not been giving discretionary awards for the last few years unless there have been special circumstances involved. If Mr Mason's application is turned down he will be able to appeal."

Mr Len Hoath, head of the school of environmental sciences at Plymouth Polytechnic, explained: "We have offered this student a place on the second year of the course and have contacted Hampshire about his case. There is a great difference between the structure and contents of the DipHE course he took and the degree programme at the polytechnic. He will have difficulty completing the degree course in two years."

The problems of transfer between the DipHE and degree courses were also highlighted this week by Mrs Christine Hague, admissions officer at Bulmershe College. She said that the mismatch of DipHE and degree programmes indicated that an increasing number of diplomates would only be offered exemption from the first year of a degree course.

"If this particular student is given an award for both years he may open the flood gates. But he did start a Higher National Diploma course before joining the DipHE and this will be his third higher education award."

New unit to monitor cost

The Council of Local Education Authorities is to set up a small unit to monitor changes in the cost of polytechnics and colleges for further education. It will also act as a troubleshooter in local authority-polytechnic relations.

The work of the unit will be independent of the advisory committee on further education being convened by Mr Fowler, Minister of State for Education, though local authority leaders have his informal approval for the plan.

The unit will probably consist of two full-time officers drawing on the services of local authority staff, Department of Education officials and academics where necessary. They will visit colleges and polytechnics by invitation "to give support to normal dealings between a college and its local authority".

CLEA expects the unit to act as a centre of information and expertise on all aspects of the finance of further education. It will be able to provide comparative data on costs and closely monitor the workings of the system of applying advanced further education funds.

It is hoped that information collected by the CLEA would be made available to Mr Fowler's advisory committee.

Final approval for the unit has yet to be given by the Association of Metropolitan Authorities and the Association of County Councils which together make up the CLEA. Some anxiety has been expressed, however, by members of the AMA about the cost of the unit, expected to be about £40,000 a year.

Next month's meeting of the AMA policy committee is being asked to approve the establishment of the unit in addition to expanding the permanent secretariat of the association.

The proposed merger of the CLEA and the Association of Education Committees is still being considered by a working party and this would bring with it additional staff and expertise.

Playspace puts on 30 courses

Music and drama therapy, natural dance, creative workshops, and psychodrama are all subjects for courses to be run next year jointly by the Polytechnic of Central London and Playspace, an educational trust.

Playspace, a group of freelance teachers, artists and counsellors, aims to promote the creative arts in the achievement of educational, therapeutic and recreational goals and to provide further education for adults and in-service training for those working in the health, social and educational services.

Together with the polytechnic it is offering a programme of 30 courses, varying in length from one week to several days, or one session a week for several months to three years, which are aimed at both professionals and non-professionals: parents and teachers, offenders and probation officers, playleaders and social workers, managers and employees.

Playspace and the Polytechnic of Central London are jointly organising a conference on music therapy and drama therapy to be held on November 11-13 at Bedford College, London. The conference will examine the status of practitioners, their training needs and existing facilities, needs and expectations of employers in those professions and music and drama therapy skills with practical demonstrations and lectures.

Former reader in economics dies

Dr Maurice Dobb, former reader in economics at Cambridge University, died last week at the age of 76. Dr Dobb was a Fellow of the British Academy, was an outstanding British Marxist economist, among whose best known works was *Studies in the Development of Capitalism*, published in 1946.

Students link arms with trade unions

by David Walker

The National Union of Students has signed the first of a proposed series of agreements with trade unions representing academic, clerical and manual staff in universities and colleges which will give them advance notice of sit-ins and demonstrations.

Mr Charles Clarke, president of the NUS, and Mr Geoffrey Drain, general secretary of the National Association of Government Officers, signed the agreement on Thursday. The agreement seeks to protect workers in universities who may be unwillingly caught up in an "occupation" or some other student action. The NUS agrees to guarantee the safety and freedom of movement of NUS members in such circumstances and NUS agrees that its members should not take action outside their normal course of duties which is directly against the interests of students in the event of student direct action.

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The draft agreement was about when student action is to take "direct action" in talks had with the Association of Scientific, Technical and Managerial Staffs.

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Vocational sub-degree courses 'should be given priority'

by David Walker

The slogan "higher education for all" should be abandoned, according to Professor Alec Ross of Lancaster University. Universities and polytechnics ought to concentrate on the fairly stable numbers of those gaining two A level entry qualifications, and any spare money for education ought to be spent on the needs of the vocational sub-degree courses in the 16 to 19 age group.

Professor Ross told the British Association annual conference yesterday: "We are misguided if we try to expand our concept of higher education to cover the diverse needs of a wide spectrum of the population."

"The logical consequence of comprehensive secondary education for all is not higher education for all, unless one does violence to the meaning of the words that is a contradiction in terms. It is instead a range of educational opportunities varying in their focus, pitched at different levels, distinctive in their organisational patterns calculated to meet not only the legitimate demands of those who seek to go on with the process of self-development begun in the years of compulsory schooling but also the needs of a society so complex in its organisation that it requires a diversity of training in those that are greater than anything known in the past."

Professor Ross's theme in his presidential address to the education section of the British Association was post-compulsory education in the 1970s and 1980s. As head of the department of educational research at Lancaster, he has been actively involved in the establishment, under his colleague Professor Gareth Wil-

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ACADEMIC DEVELOPMENTS

'Knowing your rights' boosts socio-legal studies

by Frances Gibb

The spread of law centres, welfare rights groups, claimant unions and radical law journals has provoked a burgeoning of socio-legal courses in the last few years.

A new edition to the crop is at Ealing Technical College this October, when a one-year part-time diploma course in socio-legal studies begins.

Students choose a specialization—either poverty and the law, in which they study economic aspects of poverty, poverty in society from the mid-nineteenth century, the politics of poverty and the sociology of poverty; or "offenders and the legal process", in which they cover crime and industrial society in nineteenth-century and twentieth-century Britain, the sociology of crime, and deviancy and penology.

In both cases, students must also undertake basic legal studies. The course is aimed both at practitioners and at students interested in the practical and academic issues raised by an analysis of the social context and legal realities of either the poor or the criminal offender. Although students should normally be over 21, entry requirements are flexible and the value of experience is being recognized as well as formal academic qualifications. Students may have either a post A level academic or professional qualification, or relevant practical experience.

Ealing also runs a full-time law degree course, and has recently introduced a part-time law degree course. Both contain some social science, to contribute to the analysis of law in its historical, economic, political and social context.

Government policy analysis follows American trend

by Sue Reid

Government policies will be examined by students starting a new degree course at Newcastle Polytechnic this autumn. The three-year BA honours course in Government will couple the study of politics with a detailed analysis of Government activity.

During the course, only recently approved by the Council for National Academic Awards, students will examine how better policies could be devised to meet community needs by a more effective use of resources instead of increasing the public's tax bill.

Mr F. J. Patten, principal lecturer in the polytechnic's department of administrative and management studies, said: "The emphasis of this course is on public policy in this country following the growing trend in American universities."

"American dissatisfaction with Government, especially after the Vietnam war, prompted Americans to ask not merely 'where' but 'how' did we go wrong? This encouraged their universities to put greater emphasis on teaching and research into government policy."

Students will be able to select an area of Government activity for close examination. Teams of polytechnic specialists in science and economics, politics, international relations, urban and regional problems, social policy, and transport, will guide students in their studies.

Mr Patten said: "There is evidence of a growing demand, both in government and in industry, for students who can go beyond merely criticism and probe new and better ways of meeting the needs of society. This is the task for which these students will be well equipped."

Child abuse study gets a welcome

The growing problem of child abuse will be examined in a new course being planned jointly by the Open University's post-experience unit and Newcastle Polytechnic. It is expected to be used by trainee social workers and health visitors but it has also been welcomed by police, local magistrates and doctors.

The self-instructional course will consist of 25 written units in one complete volume, accounting for about 50 hours' study. There will be supplementary audio cassette material, a reader of key writings and a package of teaching materials. But it will not be tied to radio and television programmes.

A team of consultants, including doctors, educationists, lawyers and nursing staff, have been drawn together from throughout the country to plan the course which will be available from next summer.

Miss Constance Lee, principal lecturer in the polytechnic's department of nursing and welfare studies, said: "The programme would be to assist a wide range of people whose work brought them into contact with child abuse."

These are teaching or examining trainee social workers, health visitors and others who had to cope with the problem, would be able to use the course in continuing education, or as a teaching programme.

The Polytechnic of Wolverhampton is to offer an option in marketing within its BA honours degree in business studies from this autumn. This CNAA approved option enables the year and students will now be able to specialise in this subject, transportation, and distribution, merchandising, European marketing, or product design.

A Nice way to look at European law

A new one-year diploma course in European law at Leeds Polytechnic will allow students to spend half the time abroad, at the Institut Européen des Hautes Etudes Internationales at the University of Nice.

According to a brochure prepared by staff in the department of law and international studies at Leeds, "the purpose of this course is to provide graduates from all member countries of the European Communities with a thorough understanding of the complex problems of European Community law and European integration."

The first part includes study of community institutions together with the impact of EEC law on English law. The second part, in Nice, will study the EEC's impact on French law. There will be study trips to European organisations in Brussels, Luxembourg and Strasbourg.

Applicants must have a good knowledge of French and a degree in law, economics, business or political studies. Successful students will be awarded a polytechnic diploma. The course begins in September, and before Christmas students will travel to Nice for the rest of the year.

A qualification for advertising and market research workers, a media diploma, is being launched by the Communication, Advertising and Education Foundation. The course will be the most advanced in the world, and students will study consumer media planning, industrial media planning, and advanced media studies.

The course, which is given by the department of applied acoustics, is intended for those already in industry. Students will work mainly on their own, attending the university half a day each fortnight to discuss their progress. There will be places for about 10 students.

A short course in industrial noise and vibration is to be held at Dundee University from 22 to 25 March, 1977. The course will be organised jointly by the departments of mechanical engineering and occupational medicine. It will include lectures on whole body vibration, the physiological effects of noise, instrumentation and acoustics, community noise problems, and legal aspects of noise control.



Sikh leaders at a meeting in Ealing, where the technical college has a new part-time course in legal studies.

Oxford offers Jewish studies degree

A postgraduate course called "Jewish Studies in the Graeco-Roman Period", will be available at Oxford in October, and will lead to the degree of BPhil in Oriental Studies. It has been devised for graduates wishing to specialise in inter-Testamental and rabbinic Jewish subjects and in the historical background of the New Testament.

The programme will take two years to complete and candidates will be required to present a 30,000-word thesis and pass a written examination.

Listening in to industry

Salford University is offering a new two-year, part-time MSc course in industrial acoustics from October 1976.

The course, which is given by the department of applied acoustics, is intended for those already in industry. Students will work mainly on their own, attending the university half a day each fortnight to discuss their progress. There will be places for about 10 students.

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Plymouth has new social policy and administration degree

by Frances Hill

Plymouth Polytechnic is to launch a new degree in social policy and administration this autumn. Students are offered a choice of a three-year course leading to a BA honours degree in social policy and administration, or a four-year course leading to an honours degree and the Certificate of Qualification in Social Work.

All students follow a common syllabus in the first two years, made up of social policy, administration, sociology, politics, economics, psychology, philosophy and procedures of the social sciences.

In the third year, students taking a three-year degree have compulsory courses in social theory, social policy and issues and problems in social policy, and may choose from a range of options including urban problems and policies, law and social policy, local politics, and the sociology of deviance.

Four-year students study social work methods, medical aspects of social work and other subjects of practical relevance for future social workers during their third and fourth years. They take a course in the sociology of social work, write a dissertation on a subject, included in their assessment.

Four-year students receive practical training through placements with social work agencies at the end of their second year. Placements make up 50 per cent of the curriculum during the third and fourth years. In the third year, they are sent on a "block" placement for 10 weeks, and in the fourth year they are sent on a "block" placement for 10 weeks, and in the fourth year they are sent on a "block" placement for 10 weeks.

The degree course is designed to emphasize social policy rather than the technical aspects of social work. It is intended to provide students with a broad knowledge of social policy and administration, and to prepare them for a range of careers in social policy and administration.

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Each student will be asked to prepare a dissertation on his chosen option during the year of the course. These will be compiled to form a small research project.

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Greenhouse gas biologists get grant

The Agricultural Research Council has awarded a £23,000 grant to biologists at Lancaster University who have identified a class which hampers the growth of winter crops in commercial greenhouses.

Mr Donald Moyle, reader in education and coordinator of Lancaster's Centre for Environmental Studies, said: "The discovery of the essential life processes in plants, and the way they are affected by their environment, has been a major advance in the past three years. We have shown the gas exchange of tomato plants to be 30 per cent."

The grant from the ARC will enable the team to continue their research. They hope to identify strains of plants which are resistant to the harmful effects of the gas. Ironically, the propane and butane burners, which produce nitric oxide, have been used in greenhouses to enrich the atmosphere with carbon dioxide, a plant nutrient.

Dr Mansfield said: "This week, although scientists and horticulturalists have believed there were small quantities of nitric oxide present in heated greenhouses, it had been thought that the effects of the gas on plants were negligible."

But the Lancaster team had discovered that during the winter crop, more nitric oxide than ultra-violet light was present in greenhouses, and the gas was causing damage to the plants.

The silver screen will play part in a new degree course in film studies at the University of Lancaster. The course will be the first of its kind in the history of art, and will be examined in terms of including architecture, and will be examined in terms of including architecture, and will be examined in terms of including architecture.

Works of art, aspects of film, and the history of art, and will be examined in terms of including architecture, and will be examined in terms of including architecture.

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Safety check ordered on genetic engineering

by Frances Gibb

The Government is to set up a central advisory body to supervise experiments in the genetic manipulation of micro-organisms, following the report of a working party published last week.

The working party, under the chairmanship of Professor Sir Robert Williams, director of the Public Health Laboratory Service, recommended that a voluntary system of control of such experiments be instituted.

Regulations should also be made under the Health and Safety at Work Act, 1974, to ensure that all planned experiments in genetic manipulation are notified to a central advisory body, it says.

The central advisory body, called the Genetic Manipulation Advisory Group (GMAG), would be responsible to the Secretary of State for Education and Science and have a secretariat staffed by the Medical Research Council.

It would advise on the precautions to be taken for any experiments in genetic manipulation, according to a code of practice outlined in the report.

The working party recommends that no experiments should be carried out in conditions less stringent than those used for work with common pathogens, such as staphylococci, streptococci, and salmonellae.

Even though genetic material thought to be completely harmless is being used in an experiment in genetic manipulation, it is conceivable that a hazardous product might result because of an unexpected interaction, it says.

The voluntary control system should be established quickly to provide an immediate and effective check on the hazards while permitting valuable work to proceed safely, the report says. The Government might have to consider back-up legislation to control genetic manipulation, but that should be deferred until it is seen how the voluntary system works.

The working party was set up following the Ashby Report on genetic manipulation and the report of a working party on laboratory use of dangerous pathogens. There was concern that some experiments in genetic manipulation might lead, perhaps inadvertently or unpredictably, to the release of products harmful to man, animals or plants.

The report emphasises that most of the hazards are conjectural. But the introduction of drug resistance into a drug-susceptible pathogenic bacterium could have serious consequences if the organism should escape, it says.

Mr Laurie Sapper, general secretary of the Association of University Teachers, welcomed the report. "The report of the working party on the practice of genetic manipulation, HMSO Cmnd 6600, 50p."

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New ideas scarce on time and politics

by Ivor Crewe

The 10th world congress of the International Political Science Association brought 1,500 delegates to Edinburgh last week.

Founded in 1919, to foster the development of political science by facilitating cooperation among political science associations, institutions of higher learning, research workers and professors [sic], the IPSA's survival has largely rested on the commitment of the former, plus some hefty financial backing from UNESCO.

This year it was the British PSA's turn to play host, and after a last minute cut in the UNESCO grant, to pick up the deficit as well.

The official theme was "Time, Space and Politics", which was sufficiently general to embrace what ever anybody intended to write about in the first place, but which also allowed the organizers to give a special emphasis to political geography, now enjoying a revival of interest after decades of neglect.

The predominant impression was one of workmanlike consolidation rather than intellectual breakthrough. The conference was a model of courtesy and efficiency, but the atmosphere was one of method—where hard to find, and the less orthodox, more eye-catching, themes were those that reflected recent world events ("Political Corruption: The Uncoverability of Political Untruth").

The sense of exhilaration (or alternatively profound distaste) that accompanied the new political science of the early 1960s had disappeared, as had its more extreme dimensions. There were no institutional-descriptive studies and the "Whittier political obligation" and the "What Hobbes/Locke/Rousseau really meant" brands of political thought remained out of fashion, but so also was structural functionalism, systems theory and cybernetic modelling.

The philosophical and ideological schemes that rack sociology, psychology and increasingly, economics, were blessedly absent, the reason, one suspects, having less to do with any epistemological consensus in the discipline than with a tolerant-cum-lazy acceptance of its absence.

In a letter to *The Times* last week, Mr Sheila McKelvey, health and safety officer of the Association of Scientific, Technical and Managerial Staffs, said that the union was extremely concerned about the composition of the GMAG. It should not be dominated by academics, but should have at least 50 per cent trade union representatives and others able to assess the risks as well as benefits.

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Was it all worth while—really worth while—for either participants or organizers? Did hands (let alone brains) meet across oceans? Was the "development of political science fostered"? Only the greenest of first-time participants, of course, goes in the pursuit of knowledge. Still, in these matters there are gradations. And sadly I have reached the conclusion that the larger and more cosmopolitan a conference, the poorer the quality of papers and discussion.

This meeting was no exception. The standard of papers, on average, was below that for a national political science conference; many consisting of brief notes, rehashes of past papers, or reports of current progress on research projects. A sizeable minority of speakers turned out with no papers at all. Official discussions were often not there to discuss, nor, in the case of the "Homage to Adam Smith" panel, convened to convene. The level of audience discussion, when there was any, would have made a compulsory second-year Methods class on a February Monday morning look positively sparkling in comparison.

None of this, I hasten to add, reflected on the organizers. On the contrary, the conference was a model of courtesy and efficiency, but the atmosphere was one of method—where hard to find, and the less orthodox, more eye-catching, themes were those that reflected recent world events ("Political Corruption: The Uncoverability of Political Untruth").

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in putting on these mammoth affairs at all? Do they fulfil a purpose that cannot be achieved as effectively but much more cheaply by other means?

The usual answers in defence lack conviction. World congresses may be particularly helpful to those from the developing countries, but the social sciences there are increasingly going their independent way. They may strengthen the sense of belonging to a worldwide profession, but I suspect this is only true for the well-travelled professor.

They should foster international contacts, but the more specialised and participatory "workshop", so successfully sponsored by the European Consortium for Political Research (and also on occasion by the IPSA itself), would seem a more suitable and less extravagant format.

The only function peculiar to such congresses that occurred to me was that of the "holding company": they provide an arena for smaller international groups, with real achievements in their credit, and for the entrepreneurs of future cross-national research projects. But there must be more direct ways to cater for these minorities.

None of these misgivings are dispelled by the IPSA's decision to meet in Moscow in 1979. Finding a venue is always a problem; one hand, due regard must be paid to the Eastern bloc and to the Third World; on the other, the host country must foot the bill.

Even there, the parallel with the Olympics ends. In 1979, the Soviet Union's contribution to the development of political science has been to put it mildly, obscure; indeed its notion of the subject, and its practitioners should be treated, is contrary to what the large majority of political scientists would find acceptable.

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Announcing the second year of the overwhirlingly popular Schools Prom Concerts. Perhaps the most accomplished and entertaining programme of young people's music today featuring the most outstanding young musicians from The National Festival of Music for Youth. The Schools Prom has now been developed into a two-night event with concerts on 29 and 30 November at the Royal Albert Hall, sponsored by The Times Educational Supplement.

Orchestral, ensemble, swing, jazz, wind...

In fact, all kinds of musical style will be featured... by all kinds of the most promising young musicians our schools can offer.

Introducing this score of musical talent will be well-known personalities from the world of contemporary music including Anthony Hopkins, Robin Ray, Humphrey Lyttelton and Derek Jewell.

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As happens with the Sir Henry Wood Promenade Concerts the arena seats will be removed for the concert. Both the area and the Gallery are offered at the following special low prices:

Promenade Arena 40p (80p on night) (standing not available)
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There will also be a party discount of one free seat per 12 booked seats. Schools/party travel arrangements can be made through B.U.S. School Travel Service, 190 Camden Hill, Notting Hill Gate, Kensington, London W8. Tel: 01-221 6287 contact Jill Daniels. Or your local National Travel (NBO) Ltd representative.

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You now have a choice of two nights, 29 and 30 November. Different music groups are playing each evening and promises to be equally exciting and entertaining, offering an exuberant evening's music by the leading musicians of tomorrow. The variety and range of musical content will be the same for both evenings, though not the same works.

In view of the considerable interest already shown in this unique musical event, advance booking is advisable and should be made as soon as possible, by completing the order form.

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Schools Prom, Advance Bookings, Royal Albert Hall,
Kensington Gore, London SW7 2AP.
Please send me tickets for the Schools Prom as follows:

Gallery tickets at 40p each	
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Loggia and 2nd Tier at 175p each	
Balcony (central) at 80p each	
Balcony (side) at 75p each	
Middle and Upper Orchestral at 75p each	
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Contraction is RADA's kindest cut of all

by Jeremy Clift

More often than not cuts are negatively associated with declining educational standards, but at the Royal Academy of Dramatic Art at least their effect has been wholly beneficial.

When Mr Hugh Cruttwell took over as Principal of RADA 10 years ago he decided that there were too many students, and set about contracting their numbers.

"The Academy was really too big", says Mr Cruttwell, "and over the past 10 years there has been a large reduction in the number of students. Tremendous resources are necessary to train an actor, because every student needs individual and highly personal tuition, to help him realize his full potential."

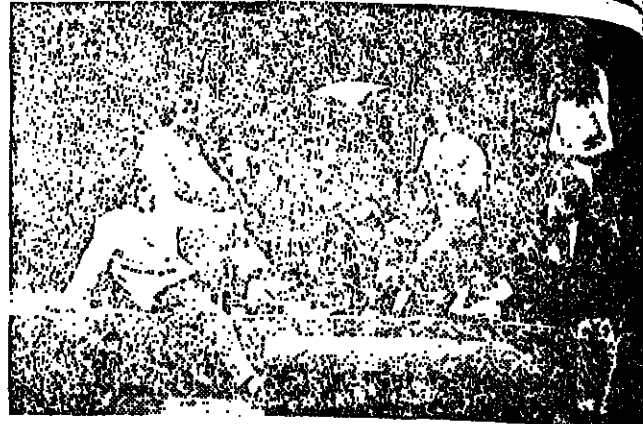
"Actors need a special kind of tuition", he argues. "You cannot stick 30 of them in a lecture hall for seven terms and expect them to be able to act at the end of it. One cannot deal with actors in large classes."

One basis, by contracting the number of students at RADA, he was able to produce a better ratio of staff to students, and thereby increase the standard of tuition that each actor was receiving.

According to one London theatrical agent it is an example that many other drama colleges would do well to emulate. For the plain fact is that there are far more actors than jobs to go round.

There are 20,000 members of Equity, but there are not 20,000 jobs", says Mr Cruttwell. "The Dancell Associates Ltd, who recruit regularly from the drama schools, especially RADA. "More than half the students at drama school will not get jobs, and it seems criminal to be training so many students."

There are currently eight drama departments in universities, and 14 schools recognized as affiliated by the Department of Education and Science, as well as a great many other colleges and polytechnics which run drama courses. More courses are due to start this academic year.



Scene from RADA's Vanbrugh Theatre production of John R. Shakespearean adaptation When Thou Art King.

At RADA there are now between 70 and 100 students, depending on the term. By far the greater part of these are acting students, on a course which lasts for seven terms, but another course of four terms caters for stage managers.

For David Lee, a 19-year-old from Harrogate, and currently president of the students' union, the acting course provides an all-round training with the stress on exercise rather than "performance".

By this he means that actors are encouraged to explore both themselves and different techniques and approaches to a particular role, rather than feel constrained by the idea that every part has to be given a "performance".

The course is strenuous, culminating in the final two terms with a continuous schedule of plays, performed in the Academy's Vanbrugh Theatre, to which acting agents are invited.

The Academy, founded in 1904 by Sir Herbert Beerbaum Tree, boasts an impressive list of former pupils, including Richard Attenborough, Alan Bates, Albert Finney, Sir John Gielgud, Judi Dench, Kenneth Williams and Dorothy Tutin, and it is this accumulated reputation which continues to attract some of the best young actors in the English-speaking world.

RADA receives no outside financial help, and runs almost entirely upon the fees-paying students for its income. Nevertheless, the college is a beneficiary from the will of George Bernard Shaw, receiving an income from the royalties from his plays, though the exact amount varies from year to year. Fees next year will be £360 a term.

Those who satisfactorily complete their training may be awarded the

Academy's Diploma, which may occasionally be an Honours Diploma for a promise. There are also awards of prizes and prizes, which is the Bancroft Cup.

Over 600 people apply for entry to RADA. As a competition is cut-throat, places for men and women. Up to one-third of the places go to students, particularly from the proportion or ratio of men to women.

Commented Glenda, a recent interview with a RADA student television programme, "I have a great influence because it is to develop without all the pressures of ordinary work forms a sort of protection against the outside world."

According to Mr Cruttwell, drama schools are world in that they train the young actor professional attitude lacking in the universities, in addition they provide a shop window.

Because the college has a reputation of the kind, students will find it easier to get jobs than most of their graduates, but overall they are twice as many students as courses each year, and they are not enough to fill the need for acting students, it is impossible.

Guiding staff through legal maze

by Frances Gibb

With more clauses of the Employment Protection Act, and a new force, the Association of University Teachers is ensuring that its members are fully aware of their rights under this and allied legislation such as the Trade Union and Labour Relations Act, the Equal Pay Act, and the Sex Discrimination Act, by issuing to every branch a "practical guide" to what the Acts say and their full implications for university staff.

Universally administrators, however, might not be so well informed, and some of the new measures creeping up on them could take them by surprise. One such measure concerns the disclosure of information. This autumn, universities will find there is a duty on them as employers to provide to appropriate trade union representatives, on request, all information needed for collective bargaining.

One of the most important examples of this is the new right of local association in university staff, which is a partial scale introduced for professors. In the course of negotiations it asks the university how many professors are paid in a particular way, and the university refuses to give the information.

The local association may then go to the Central Arbitration Committee and complain. The Committee must ask the University to disclose the information. If the University refuses to give the information, the Committee can order it to do so. If the University still refuses, the Committee can order it to pay compensation to the staff.

On the question of redundancy, the guide notes that the AUT is generally opposed to redundancy of staff.

The issue will then be decided by the Committee who may consider a partial scale is justified and award accordingly. This then becomes part of the terms and conditions of employment of every professor in that university.

The guide states there are exceptions where the employer is not required to disclose information. These include national security information, information which would contravene an Act of Parliament, and information which has been sent to an employer in confidence about an individual, unless he or she has consented.

Dismissal of members of staff becomes more difficult under the new legislation. It will no longer be enough to dismiss members of staff under the regulations of the universities; every member of staff will also have the right to take the case to the industrial tribunal, who will have to be satisfied that the dismissal was justified.

If the tribunal is unconvinced, the employer must be taken back, or paid compensation, which could be as high as £11,000, the AUT guide says.

The regulations do not apply to employees with less than 12 months' service. At present, a full-time employee is someone who works for 21 hours a week or more, but shortly will be redefined as someone who works for 16 hours a week, or more, or eight hours a week if an employee has worked for the same employer for five years or more.

On the question of redundancy, the guide notes that the AUT is generally opposed to redundancy of staff.

Where redundancies do occur, the guide says, they should be made except

where staff are on fixed term of two or more years and pay and employee has the right to be excluded from the terms of the new contract.

Under the new legislation, the union must give notice to the employer of its intention to take action, and the employer must give notice to the union of its intention to take action.

Rights relating to conditions of employment strengthened under the new legislation. Even where there is no agreement on an issue, the union can go to the industrial tribunal, who will have to be satisfied that the dismissal was justified.

Mr Sapper gives the example of a university "Y" in the north of England, which has been a university for 100 years, and has a long history of excellence in the area. The union has asked for its terms to be reviewed to the level of other universities, and the Central Arbitration Committee has agreed to do so.

Since the Committee of Chancellors and Principals has refused to set up a negotiating machinery on conditions of employment (other than salaries), the union has to go to the industrial tribunal, who will have to be satisfied that the dismissal was justified.

Employment Protection Act. Legislation for Local Association of University Staff. United House, 11, Pemberton Road, London W11 3H.

David Walker reviews the history of research into the social effects of the North Sea oil boom

Oil impact research runs into stormy weather

The exploitation of the oil fields off the North East coasts of the British Isles has roused not only rustabouts, drillers, Texaco, trouble-shooters, camp-followers and derrick erectors, but also normally placid academic social scientists. The pursuit of knowledge about North Sea oil and its impact on the North East has been fraught by bluntness and depth of feeling that in its own way perfectly matches the energy of the professional oilmen.

Anyone present at last year's British Association meeting at the Society devoted to the work of the Social Science Research Council, or witness to three years' exchange of letters, grant applications and telephone calls between SSRC headquarters and certain departments of universities, will know of official enthusiasm and deeply wounded pride topped by mounting frustration.

Now seems a good time to review the history of social scientists and North Sea oil. The SSRC's own special North Sea oil panel has been functioning for several months and has recently issued its first bulletin, appealing for applications for the £150,000 it has allocated for work on the impact of prospecting, platform building, oil storage and installation building in the triangle bounded by Aberdeen, Inverness and Lerwick in the Shetlands.

Attached to the bulletin is a catalogue of research actually being done on the impact of oilfield developments, including an extensive study of the economic effects by Professor Donald Mackay, formerly at Aberdeen but now at Heriot-Watt University, and a survey of the effects of oil on the provision of leisure and recreation in the Highlands and Islands by Professor J. T. Coppock and others of the University of Edinburgh.

Two things are striking about the list. First, it appears rather late in the day. Oil has been flowing for several months now and before the Queen turned the tap there were of course years of exploring, platform building and so on—activities with possibly devastating effect on the quiet Scottish ports where they were carried on.

What is also striking is the absence of any contribution by the sociology department at Aberdeen University, not only the university nearest the oil but containing one of the three largest departments of sociology in the country. The omission brings to mind the interdict laid on the SSRC at the British Association meeting by Dr Robert Moore, reader in that department.

Dr Moore said: "We have had to get on without the SSRC in this field for five years now. The SSRC has studied initiatives on research, but it has not been able to do them. Most of the work now being done. Much effort will have been put into research which has been expended trying to persuade the SSRC and other agencies of the need for broad-based, coordinated and systematic research to be undertaken as a matter of urgency."

At this late point all we have from the SSRC is a new committee with a paltry sum of money at its disposal to be spread over four years and at least three disciplines. This sum would not pay for one good project in one discipline. So the SSRC subject committees, and not its new committee, remain the main source of finance and the new North Sea oil panel is as irrelevant in financial terms as it is confusing administratively.

The need for research into the problems created by the sudden exploitation of oil has been recognized for several years by the Scottish Office and local authorities. Last spring the Grampian regional council called for a "national strategy" to deal with the onshore impact of oil and gas. They forecast that between 1976 and 1981 there should be an increase of 10,000 jobs and an advance in population of 15,000. On the academic aspect of these problems, the SSRC sociology committee, set up in June, 1974, that it recognized the importance of research.

Upheaval

That importance has been re-emphasized on many occasions since, and it puts the question whether enough has been done and whether a major social upheaval, in early 1975 sociology department at Aberdeen, then head of the department in the area. The union has asked for its terms to be reviewed to the level of other universities, and the Central Arbitration Committee has agreed to do so.

That was said when the SSRC was launching its initial advisory group on North Sea oil research, the forerunner of the present North Sea oil panel, led by Professor Fred Martin of Glasgow University.

Professor Carter, together with Professor G. Sadler, who is head of the Institute for Social Studies at Aberdeen, were the first to be applied to the SSRC for £50,000 in April 1974, to study the social impact of oil on communities in the North of Scotland. Together with Dr Moore they applied in August of the same year. In the same month Dr Moore submitted proposals for a pilot study of migrant labour. Early this year Dr Moore and a research

assistant applied for £10,000 for a study of migrant labour. The only one to receive funds was Dr Moore's pilot study on migrant labour, whose value was £6,000. The Scottish Office gave Professors Sadler and Carter a one-year contract for a study of the impact of oil.

Between the lines lies a sheaf of correspondence between Aberdeen and the SSRC, three detailed rejections of research proposals, anger, threats of libel actions, the upshot of which is that little sociological work has been done on the impact of oil. Dr Moore considers the story has lessons for a student of social sciences methodology, for it illustrates how a research project is compromised by the process of applying to a bureaucracy such as the SSRC.

Rejection

For the student of British institutions, the story tells of the importance of geographical distance. Members of the SSRC staff and academics on the sociology grant committee betrayed lamentable ignorance of the geography of North East Scotland.

It also reveals large gaps between the various SSRC committees and poses questions about the role of the permanent officials and the responsibility of the academics who run the council. There is, too, a study of personalities. Academics devoted to the life of the mind, and SSRC officials, devoted to lubricating the life of the mind, remain individuals susceptible to anger, pique, and in the words of one of the actors, "sheer bolshiness".

The core of the matter is the rejection of the various grant applications from the Aberdeen social scientists. The latter say that the terms of the rejection betray contradictions and they have independent testimony to the value and quality of their applications. Behind the SSRC's decisions lie the academic weight of its committee members and the referees they choose to consult. Academics from older and more established disciplines than sociology could perhaps be forgiven for saying it was another case of a subject insufficiently "scientific" to transcend mere opinion.

There are positive aspects to the story, even if knowledge about the impact of oil on the population of North East Scotland has not been advanced very far. Dr Moore and his assistant Mr Dan Shapiro have laid down the basic lines of understanding how labour flooded into the North East. Professor Sadler's institute has started cooperative work with academics from Norway and other countries on the dynamics of areas with small and largely rural populations, and hence of the possible effects of an incursion of town-based industry and employment. The SSRC's North Sea oil panel was finally set up to coordinate research and might yet prove a useful focus.

Perhaps there are lessons to be learned by other sociologists from what in many respects was an interesting dispute. Dr Moore is an active and influential member of the British Sociological Association, as is Professor John Eldridge, who is on the SSRC North Sea oil panel, and Dr Cyril Smith, secretary of the SSRC: together they are surely able to abstract any general lessons the experience might have.

State controls worry sociologists

For a few days in the middle of August, 1975, Scandinavian sociologists invaded the small Swedish University town of Lund for the ninth bi-annual conference of the Scandinavian Sociological Association.

The average age of the delegates appeared to be around 27, undoubtedly a misleading impression as this seems to be the age of all Scandinavians, more than usually so after a long, hot summer.

Despite their youthful and energetic countenances, delegates from all countries shared a pronounced scepticism concerning their ability to influence the world in general and governments in particular and the willingness of the state to listen to opposing viewpoints, except via an occasional bug.

The professor of sociology in Uppsala, Ulf Himmelman, vice-president of the International Sociological Association, recently alleged that this had in fact happened to him. Ironically, he was at one time a member of the governmental commission set up to investigate state intelligence operations.

As was particularly apparent in the panel discussion, the brightly idealistic generation in sociology is growing, if not older, certainly a lot wiser. Compared with their British colleagues, Scandinavian sociologists seem more confident that they will somehow be provided for in all their multitude.

Most of them are well versed in empirical research which planned societies are built around, and meritocracies can always do with more and better educators, especially with the present trend towards more flexible short term planning.

The issue is what kinds of researchers and educators are needed. Will the technocrats take over in this future of "ad-hocracies"? How to present controversial research findings and teach socially critical truths without being charged with politicking and dogmatism was the five thousand dollar question that was raised and re-raised and remained unanswered.

As expected, those already in government bureaucracies expressed the greatest faith in the strength of scientific integrity.

Göran Therborn, whose recent Marxist history of Sweden has made him one of Sweden's most well-known sociologists abroad, offered three proposals on what is to be done in the struggle to deal with growing governmental procedures: Sociology as a profession needs to be strengthened to protect basic research and publicly question every interference; union activity should be supported; the rest is active political involvement.

The star speaker was Hans Zetterberg, who after many years in the United States has returned to Sweden and is now managing director of his own opinion research centre. In a bright red checked shirt he did not look much over 27 either.

He informed us of a new statute of the Swedish government giving their own statistical bureau virtual monopoly over all survey work to be done in the public sector.

His fear concerning the possible consequences, for independent, critical and innovative social thinking was shared by everyone. British sociologists should perhaps hope that in this instance their government will be as ineffective in learning from the Swedish experiment as they have been in others.

In 18 work groups a great number of papers on a variety of topics were discussed, ranging from terror campaigns in Chile to female post-office workers in Norway. The group on the Sociology of Women stood out as the most lively and exciting and a great deal of research is going on, particularly in Norway.

What needs to be known and what is to be done is there for all, or at least all women, to see. It only remained to ask Zetterberg about grandmothers, as opposed to grandfathers' opinions, and to convince male sociologists that women are not just another woman's problem, but a problem of power both for sociology and for the state.

Eva Stina Lyön

The author lectures in sociology at the Polytechnic of the South Bank.

NOTICE BOARD

Appointments

Universities

Hull
Lecturers: D. Collett (mathematical sciences, temporary); G. Hinchcliffe (politics, temporary); A. Kewley and J. A. W. Prosser (law); J. R. Lobner (sociology and social anthropology, temporary); D. R. Meller (social administration, temporary); A. Mughella (drama, temporary); M. J. Ryan (economics and commerce, temporary); L. K. Singh (electronic engineering, temporary). Research fellow: R. Pollock (chemistry). Research assistants: B. Butler (applied physics); I. S. Carter (biochemistry); P. B. Christmas and V. Skolton (educational studies); T. B. Maus (Institute for Health

Studies). Lecturer: D. Lohel (French). Deputy warden: S. E. Brown (Hawthall). Assistant librarian: D. A. Pender (Brynmor Jones Library). Physical education assistant: V. Gault (Sports Centre). Administrative assistant: M. J. Pedley (adult education).

Leeds

Senior Lecturer: Richard P. Smith (psychiatry). Lecturers: Alan Chatterton (nursing and medical sciences); Stephen R. Clarke (education); David Cotterell and William Winslow (physiology); John C. Barrett (adult education and extramural studies); Marjorie Chatterton (civil engineering); Sarah C. Fildes and Richard C. J. Kilmister (sociology); John W. Graham (Wulfever Marine Laboratory); Paul E. Hughes (animal physiology and nutrition); Gary W. Knapman (Overseas Education Unit of the Institute of Education); Charles

J. Mitchell (medicine, St James's Hospital); Penelope E. A. Newman (Spanish and Portuguese); Brian P. Richardson (Italian); John H. Brad (obstetrics and gynaecology); David Fairclough (School of English). Temporary lecturers: John C. Childs and George Cameron Peden (school of history); Martin H. Adams (music); Richard Buckham (theology and religious studies); Mark S. Haggood (law); J. A. MacDonald (physiology); Senior visiting fellow: Lindsay Farrell (philosophy, division of history and philosophy of science). Research fellows: Brian D. Chaney (biochemistry); Kevin J. Odell (Inorganic Chemistry); Warren F. Walker (pure and applied zoology); Peter E. Jupp (statistics). Reappointed lecturers: Brian E. Ratcliffe (civil engineering, temporary); L. G. Williams (Institute of Transport Studies, temporary); R. Zim (temporary) and Dr Joanna Dale (school of English).

Honorary degrees

Edinburgh

DLit: Professor E. C. Mossner, professor emeritus of philosophy and philosophy of science, University of Texas. Sheffield
DSc: Mr. Christian J. S. Boulton, mountaineer, writer and photographer, leader of the British Everest expedition of 1972 and 1975.
D Eng: Professor Sir William Hawtrey, former head of the department of engineering, Cambridge University.
LLD: Dr Harry T. Hookway, deputy chairman and chief executive of the British Leyland.
LLD: Ms Margaret Drabble, novelist, and Sir Roger Myrnes, former professor of Latin at Oxford.
DMus: Sir Michael Tippett, composer and former artistic director, Bath Festival.

Forthcoming events

In celebration of 100 years of tertiary adult education in London, the Department of Extra-Mural Studies will hold the following series of days between 6-7 pm in the Queen Mary Centre, 100, The Strand, London WC2R 2AL.
"The Search for the Self" by Professor J. H. W. MacLennan, former head of the department of English literature, University of London.
"The Search for the Self" by Lord Justice of Appeal (Sir) Lord Havers, former head of the department of English literature, University of London.
"The Search for the Self" by Lord Havers, former head of the department of English literature, University of London.
"The Search for the Self" by Lord Havers, former head of the department of English literature, University of London.

Why must the art teachers suffer?

Brian Allison criticizes the way the DES has allocated art teacher training places

The recent allocations to polytechnic and college education of teacher training placements for 1977 have not unexpectedly brought some surprise and despondency to many of the institutions concerned. The receipt of these allocations is the strongly held view that they have been hastily conceived, and show an alarming insensitivity to the realities of teacher training organization and structure. Within what appears to be yet another manifestation of weak planning based on inadequate information and misinterpreted statistics, attention needs to be drawn to the anomaly of the specific allocation of placements for art and design teachers on what are generally known as the Art Teacher's Diploma/Art Teacher's Certificate, or ATD/ATC courses.

The ATD/ATC courses are one-year specialist teacher training courses for art and design graduates and prepare teachers for general and further education, as well as for specialist work in a variety of institutions in other fields, including social work and therapy.

Over the years the 14 art teacher training centres have developed a level of expertise and experience which is not paralleled anywhere else in the world. The ATD/ATC courses form part of an academic structure which includes direct relationships with schools, libraries, museums and galleries, and a high level of postgraduate training for teachers of a particular subject area.

The fact that this specific form of postgraduate training for teachers of a particular subject area has been singled out for a 50 per cent cutback, when no other subject or form of teacher training has been similarly identified, is a matter of national concern, and one deserving the most rigorous inquiry at the highest level.

Various articles in *The Times* in recent months have justly drawn attention to several inconsistencies and anomalies in the deliberations of the Department of Education and Science on art teacher training.

The inconsistencies surrounding the recent 1977 allocation of places on ATD courses are, perhaps, the most alarming of all and raise serious questions as to the motives underlying the DES action, as well as its effect on the art teacher training system.

Although the ATD courses vary considerably in organization and validation, they share a common characteristic in that all applications for the courses are made through a central body, managed by the central government.

It is not relevant here to discuss the relative merits of these different forms of specialist art teacher training, but it is important to note that the ATD form which is being reduced far in excess of the other four forms of training.

Unless this view regarding the relative merits of the concurrent BEd as against consecutive PGCE is one which is only being applied to art and design, then the DES is making a clear policy decision which should have resulted in the PGCE total targets being reduced by the same proportion as the Art/BEd.



Learning to draw—but will there be enough teachers to pass the skills on to others?

time that not only were the ATDs to be categorized as PGCE students, but also that the ATD course was to be included within the targets already set for the institutions which had been based on other courses, the difficulties and embarrassment of those ten institutions were paramount.

Whilst the problems of incorporating the ATD numbers in the 1981 targets for the 10 institutions are extreme, the magnitude and nature of the cuts in ATD numbers for 1977 is staggering.

It should be noted first that until now the ATD courses have not been subject to an annual allocation and are very much related to BA (Art and Design) output and, secondly, the ATD is the only subject group to be singularly identified for specific reduction.

Overall, the reduction for 1977 of the ATD national total from over 850 to 500 is more than 40 per cent. As the reduction can only be directed in the 10 institutions in the maintained sector, the actual reduction in those centres exceeds 50 per cent, and includes the closing of the Centre in York, and the reduction of the ATD numbers in the other nine centres.

By comparison, the PGCE total, which by now includes the ATD, is to be reduced from 10,600 to 10,000 or, in other words, a 6 per cent cut.

The singular attention to cutting back the ATD numbers is of great significance, particularly as the DES, in April 1976, saw the ATD as only one of a number of forms of specialist art teacher training which in relation to the 1981 proposals they referred to the need for consideration to be given to the "total proposed provision within the reason concerned of specialist art teacher training, including that via three and four-year concurrent, one-year specialist, PGCE and ATD courses."

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Unless this view regarding the relative merits of the concurrent BEd as against consecutive PGCE is one which is only being applied to art and design, then the DES is making a clear policy decision which should have resulted in the PGCE total targets being reduced by the same proportion as the Art/BEd.

The DES now frankly admits that it failed to take into account the numbers of ATD students of the institutions of the Centre when the target figures were set. Even as late as November 1975, the DES was unsure as to whether or not the 800 or so ATD students would eventually be included in the 61,000 to which the total was to be reduced.

Richard of York's battles may not have been in vain

Michael Gruneberg and Joe Monks discuss how mnemonic aids can help students to pass exams

The use of memory aids to improve the power of recall has been known since the Greeks, and many such aids are in everyday use. For example, using the first letter of items as cues to later recall, as used in the case of Richard of York's Battle in Vain to give the colours of the rainbow.

The use of memory aids as an aid to studying is, in fact, generally frowned upon by educators, who argue that, if something is worth learning, there is almost always a meaningful way of learning it, and that memory aids merely facilitate rote learning. However, to take this position is to overlook the enormous memory load which is placed on students in final examinations in many subjects.

The reality is that many students have to learn, in a short period of time, an amount of material for the purposes of an artificial examination system. Furthermore, the distinction between meaningful and more rote learning is an artificial one in this situation.

For example, where a student is required to give the arguments for and against capital punishment, this would be quite possible to revise on the argument concerning deterrence, under examination stress. Such an omission need not indicate a lack of understanding as opposed to memory failure.

At any rate, what educators think, and what students actually do, are not necessarily the same thing, so we thought it worthwhile to investigate the extent to which students actually did apply mnemonic aids in examination preparation.

The first study involved a survey of all psychology students who had graduated in the psychology department in University College, Swansea, since its inception. Ex-students were asked, by means of a postal questionnaire, whether they had employed mnemonic aids in their final examination preparation, if so what had they employed and, if they had not used mnemonics, what method of study had they used.

Of the 74 per cent who responded to the questionnaire, 34 per cent of single honours students reported using mnemonic techniques at least "sometimes" in order to help them retain points they wished to make in essays.

The most common technique used involved the use of the first letter of a word to remember a word. Many of those not using mnemonic aids used purely rote learning techniques in order to learn points they wished to make in essays.

One interesting finding to emerge is that there was no difference in examination performance between those reportedly using and those not using mnemonic aids.

There are, of course, a number of possible reasons for this. However, it does appear that if such aids do not do any positive good, they cannot be shown to do any positive harm.

One student who used mnemonic aids and who obtained a 2.1 degree in psychology, wrote: "I have rearranged them into a coherent whole (lecture notes and notes from journals, and so on) till they satisfy my ideal answer to the examination question. That my imagination presupposes a progressive reduction of the notes, which at the same time helps to impress the salient features of the topic upon me. After perhaps three or four reductions, only a group of single words is left, each of which is the starting place for a separate point, maybe several paragraphs long, which I can expand at will."

For the individual psychology course I have 15 mnemonics whose length varies from 15 to 30 letters, the total number of letters to the retained altogether is 323. For the developmental psychology, the mnemonic's length ranges from five to 25 letters, being 12 mnemonics altogether and in letters 152.

Taking account of all that was learned in information theory, the 15 and 12 mnemonics are split into two, and two key mnemonics are constructed, specially, by the first word in each of the 15, on two separate mnemonics, thus in the latter, the first word is made with this point in mind.

The words in the key mnemonic (six or eight) should each set off one of the words in the string of other mnemonics—which have been tested before an examination. Once in the examination room the first thing done is to write all the mnemonics down and then look at the key mnemonic.

A second survey indicates that the use of such techniques is certainly not confined to psychology examinations. Forty-seven per cent of first year students attending a psychology lecture reported using such techniques in GCSE subjects such as history, geography, mathematics, physics and chemistry, and most of all biology.

A final survey we conducted also showed the extensive use of mnemonic aids in medical examinations. This would be quite possible to revise on the argument concerning deterrence, under examination stress. Such an omission need not indicate a lack of understanding as opposed to memory failure.

The results indicated that over 50 per cent of students used mnemonic aids, usually first letter clues, at least "sometimes" in anatomy, although the reported use was less frequent in physiology and biochemistry. Many students gave examples which were somewhat obscure, possibly an additional aid to retention.

Several students also reported that mnemonics are best when given by lecturers and the mnemonics supplied by the lecturer made the lectures more interesting.

The experimental evidence on the value of first letter mnemonics is in fact meagre. What evidence there is suggests that such mnemonics help in the retention of the order of material, rather than of the material itself, although we recently found that both order and item recall were improved by using memory aids.

Our experiments have involved using lists of colour materials, such as lists of bird flowers and on, whereas other studies have used unrelated words. In one of our experiments subjects using mnemonics took longer to learn the word lists than another group using ordinary rote learning methods.

However, the longer time taken to learn was controlled for in another experiment and mnemonic aids were found to be superior to ordinary rote learning in any subsequent recall.

In addition to any experimental evidence, there are other reasons to suppose that mnemonic techniques might be useful aids to study. An interview conducted with one girl who obtained a first-class degree, and who employed mnemonics, strongly pointed to the importance of the confidence and self-belief in her ability to remember.

Against this argument that constructing mnemonics increased the enjoyment of the study process, and resulted in her spending longer thinking about and organizing material that was to be retrieved by the use of mnemonics.

Present-day examinations do involve a tremendous memory load, they are artificial situations. Procedures which enable individuals to perform of their best in terms of putting down what they know are surely not to be discouraged.

The authors are members of the department of psychology at University College, Swansea.

Grants

Universities

Birmingham
Physical metallurgy—£37,962 from the SRC for work on X-ray dispersive analysis and scanning transmission electron microscopy under the direction of Professor R. E. Smallman and Dr M. H. Loretto. £4,897 from the SRC for a senior visiting fellow, Professor M. Hagger, £1,008 from the Ministry of Defence for constitutional and magnetic studies of metal fluorides and oxides under the direction of Dr R. E. Smallman. £1,008 from the SRC for a senior visiting fellow, Professor M. Hagger, £1,008 from the Ministry of Defence for constitutional and magnetic studies of metal fluorides and oxides under the direction of Dr R. E. Smallman. £1,008 from the SRC for a senior visiting fellow, Professor M. Hagger, £1,008 from the Ministry of Defence for constitutional and magnetic studies of metal fluorides and oxides under the direction of Dr R. E. Smallman.

Open University programmes September 4 to 10

Saturday September 4

SEC 2
7.00 Mathematics Foundation Course: Basic Algebra and Trigonometry (1976-77).
7.30 Mathematics Foundation Course: Basic Algebra and Trigonometry (1976-77).
8.00 Mathematics Foundation Course: Basic Algebra and Trigonometry (1976-77).
8.30 Mathematics Foundation Course: Basic Algebra and Trigonometry (1976-77).
9.00 Mathematics Foundation Course: Basic Algebra and Trigonometry (1976-77).
9.30 Mathematics Foundation Course: Basic Algebra and Trigonometry (1976-77).
10.00 Mathematics Foundation Course: Basic Algebra and Trigonometry (1976-77).
10.30 Mathematics Foundation Course: Basic Algebra and Trigonometry (1976-77).
11.00 Mathematics Foundation Course: Basic Algebra and Trigonometry (1976-77).
11.30 Mathematics Foundation Course: Basic Algebra and Trigonometry (1976-77).
12.00 Mathematics Foundation Course: Basic Algebra and Trigonometry (1976-77).

Sunday September 5

SEC 2
7.00 Mathematics Foundation Course: Basic Algebra and Trigonometry (1976-77).
7.30 Mathematics Foundation Course: Basic Algebra and Trigonometry (1976-77).
8.00 Mathematics Foundation Course: Basic Algebra and Trigonometry (1976-77).
8.30 Mathematics Foundation Course: Basic Algebra and Trigonometry (1976-77).
9.00 Mathematics Foundation Course: Basic Algebra and Trigonometry (1976-77).
9.30 Mathematics Foundation Course: Basic Algebra and Trigonometry (1976-77).
10.00 Mathematics Foundation Course: Basic Algebra and Trigonometry (1976-77).
10.30 Mathematics Foundation Course: Basic Algebra and Trigonometry (1976-77).
11.00 Mathematics Foundation Course: Basic Algebra and Trigonometry (1976-77).
11.30 Mathematics Foundation Course: Basic Algebra and Trigonometry (1976-77).
12.00 Mathematics Foundation Course: Basic Algebra and Trigonometry (1976-77).

Tuesday September 7

SEC 2
7.00 Mathematics Foundation Course: Basic Algebra and Trigonometry (1976-77).
7.30 Mathematics Foundation Course: Basic Algebra and Trigonometry (1976-77).
8.00 Mathematics Foundation Course: Basic Algebra and Trigonometry (1976-77).
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Wednesday September 8

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Thursday September 9

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Friday September 10

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Saturday September 11

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Sunday September 12

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Saturday September 18

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NORTH AMERICAN NEWS

MICHAEL BINYON reports
from Washington

The Times Higher Education Supplement (London)

Tel. (202) 638 6765

Room 541
National Press Building
Washington D.C.Warning of imbalances
in medical training

America is in "serious danger" of developing too many medical schools, and should stop relying on foreign medical graduates to meet the present need for doctors, a study on health manpower says. But it also gives a warning that Government attempts to make up for the geographic maldistribution of health manpower and overspecialization in medicine could lead to "excessive and unwieldy" Federal Government controls.

The study by the Carnegie Council on policy studies in higher education is based on health manpower projections up to 1990. It found that there was a reported shortage of 50,000 doctors in the United States in 1970, but by the end of last year the total number of active physicians and osteopaths had gone up from 323,000 to 378,000, a rise of 55,000.

There were now 114 medical schools training students, 13 more were in various stages of development, and many more were being proposed in various communities. The council says this will lead to an oversupply, which could be very costly: "a new medical school costs as much as \$100m."

The council thinks new schools are not needed except for those being built in Wilmington, Delaware. It also supports special medical education programmes in Georgia and Arizona which are designed to encourage minority groups to train for the medical profession.

Attempts by Congress to direct doctors to areas of need (THESE, July 16) by setting quotas for medical schools that wanted to get Gov-

ernment money were very dangerous, the council report said; the objectives might be desirable, but legislation to this effect was an "unwarranted interference with the academic decisions of the schools." Instead, medical and dental schools should be automatically given federal support because of the social benefits they provided.

The council suggested that instead of setting financial conditions, the Government should make extra money available to encourage medical schools to graduate more general practitioners and less specialists, improve health care in university communities, decentralize medical and dental education, increase the enrolment of women and minority groups, and reform the curriculum to give students more early exposure to clinical experience.

A few years ago, the report says, about a fifth of all practising doctors and nearly a third of those in internships and residencies in the United States were foreign medical graduates.

The council urgently recommends that university health centres should be given stable financial support, that the Federal Government should cooperate more to get a better geographic distribution of doctors, there should be incentives rather than controls to encourage the training of general practitioners, and the Government should fully support medical research. Finally, the report says, mortality rates in America are "excessively high, chiefly because of unwieldy personal habits and high accident rates."

Second chance for West Point cadets who cheated

West Point cadets convicted of cheating in an out-of-class examination in March are to be given a second chance. Mr. Martin Hoffmann, Secretary of the Army, last week set aside the automatic expulsion penalty, and said cadets found guilty in the current investigation will be allowed to return to the United States Military Academy after a one-year suspension if they can demonstrate their qualifications for a military career.

Testifying before the Senate armed services manpower and personnel subcommittee, Mr. Hoffmann also said that West Point had now abolished similar out-of-class examinations which could not be supervised.

The scandal at West Point—the cheating in the academy's history—was to be set up by Mr. Hoffmann, a former astronaut and now president of Eastern Airlines. Mr. Hoffman, himself a West Point graduate, whose two sons also

attended the academy, will evaluate the whole honour code and recommend changes.

For the moment however, the code—that a cadet "will not lie, cheat or steal or tolerate those who do"—will remain in force.

Mr. Hoffmann's intervention in the scandal, coming after mounting pressure within Congress, has given scope to the inquiry now hearing cases at West Point has grown wider and wider. He made it clear that the softening of the traditional penalty is a one-time only exception. Cadets already convicted will still be expelled, but may reapply for admission next spring, and will be judged as though they were applying for the first time. In the past, they were expelled forever.

Cadets already convicted were detected, and those uninvolved did not agree with the readmission of the guilty. Of those charged so far, 88 have been found guilty, and 12 others have resigned. Hearing by officers' board continues.

Pensioners can attend Rutgers

Senior citizens, aged 62 and over, can now attend Rutgers, the state university of New Jersey, free of charge, under a recently expanded programme.

All New Jersey residents are eligible, and can enrol in any department of the university on a non-credit basis as long as a place is available. There is no limit to the number of courses the senior citizen can take but since the pro-

gramme was first tried out on a limited basis last year, most students have taken only one or two a semester.

Rutgers has managed to start the scheme on its campuses in Newark and Camden and lower the quality of age from 65 to 62 in spite of severe budget cuts imposed in the university earlier this year because of the recessionary state of New Jersey's finances.

Space and energy programmes boom

Research spending may top \$34,100m

Spending on research and development in the United States is expected to reach \$34,100m this year, a 9 per cent above the 1975 level of \$31,200m, according to a report published last week by the National Science Foundation. Allowing for inflation, this is still a 2 per cent rise, and is a healthy sign after a decade of falling funds.

Research and development expenditures are expected to account for 2.2 per cent of America's estimated 1976 gross national product. Expenditure for basic research is expected to rise 7 per cent between 1975 and 1976, while funds for applied research and development are expected to grow 8 and 9 per cent respectively. Allowing for inflation, each is expected to increase by 1 to 3 per cent.

The NSF estimates that 530,000 scientists and engineers were employed in research and development activities during 1975, 1 per cent more than in 1974. Two

of these professionals worked for industrial firms. About 16 per cent were employed in universities and colleges and their associated Federally Funded Research and Development Centres. Another 12 per cent worked for the Federal Government.

The figures are contained in a foundation report that looks at funds and manpower for research and development in the United States from 1953 until now. It covers four sectors of the economy: the Government, industry, universities and colleges, and non-profit institutions. It is updated every year.

Other figures published last week by the foundation show that both space and energy research programmes are expected to show sharp rises next year. The research and development programmes for the National Aeronautics and Space Administration in 1977 will

increase by \$99m over this year's estimated \$3,500m. The energy research and development funding 15 per cent of the total.

The programmes of the Federal Research and Development Administration are expected to grow by \$476m next year, a 10 per cent increase. The budget for 1977 is \$3,300m—about 1 per cent of the Federal total.

Next year nearly three-quarters of the Federal Research and Development Administration will support work under Federal Government. The rising \$6,100m will support work under development programmes conducted by Federal personnel in the form of direct or indirect administration.

Vocational research under fire

The Government's \$250m research in the past 10 years into vocational education has been almost useless, according to a study by the National Academy of Sciences. It had virtually no impact on the knowledge, skill or employability of a large number of students.

The study, commissioned by the US Office of Education, blames politics and bureaucracy for the lack of results. Many problems have either been ignored or swept under the carpet. Restrictions have been put on the research money is spent, the best qualified researchers have not always been employed, and the Government's research and development programme is uncoordinated, the results poorly disseminated, and money has been spent on training personnel rather than producing usable products.

The study found that objectives of the research have never been clear, and there was insufficient data. What the Office of Education would need, the study suggests, is to evaluate vocational education on the basis of long-term studies into wages, training cost savings, job satisfaction and so on.

The academy suggested that a panel of consultants appointed by the President should look at all aspects of vocational education, including the research, and report every five years. In addition the office of education should sort out a proper method of disseminating the results of research, bring number of different research programmes together, and cut all the red tape.

This indictment of Government efforts to see whether vocational education is really working or not may explain why there has been so much criticism of vocational education in recent years. Administrators all have different ideas of exactly what vocational education in schools is meant to be or do, and many professional educators have cast doubts on its usefulness. A Bill is now making its way through Congress to change the way vocational education is funded.

Meanwhile, the Centre for Vocational Education in Ohio has just published a report on the state of vocational education under contract with the Office of Education. The research was intended to find out how vocational education programmes should be matched to the needs of disadvantaged black youths.

The report is startling for its complete lack of any significant findings. It found, on the basis of a sample of 15-year-old male blacks in Baltimore schools (which it admitted could not be statistically generalized) that the attitudes of black and white students to vocational education were extremely similar. Pupils did not have a negative attitude of the programme, and so there was no need to do anything to improve it. To do so, they thought the programme enjoyable and useful were more likely to own a part of vocational education, but most could not see the difference between this and any other form of education.

Chicago gets \$3m to ensure survival of dictionaries project

Two monuments of esoteric scholarship at the University of Chicago—dictionaries of the ancient Hittite and Assyrian languages—have just received almost \$750,000 in government funds to ensure their survival.

The Assyrian dictionary, which was started 55 years ago, is a vast project which has already cost more than \$1m. When complete it will consist of 21 volumes with more than 20,000 words used by the ancient Babylonians and Assyrians. Twelve volumes have already been completed, and a grant of \$510,540 from the National Endowment for the Humanities will finance the preparation of at least three more.

The Hittite dictionary has not yet begun. A grant of \$219,882 by the endowment will support the project to take out 10 years, beginning late next year. It will be published in eight to 10 annual instalments.

The Oriental Institute at the University of Chicago is a world centre for the study of the ancient Near East. It has probably the finest museum of antiquities from this area (some of which have been exchanged with others from the British Museum).

The Assyrian dictionary has up till now been financed entirely by the university and occasional contributions. It has become almost a symbol of Chicago's dedication to pure scholarship, although questions are frequently asked about its ultimate use.

Actually the language being surveyed is not Assyrian but, more properly, Akkadian, composed of two dialects used by both the Assyrian and Babylonian peoples. Their civilization flourished from 2500 BC to AD 100 in the area which is now Iraq. Records of the language were first found in what was the development of words and their meaning through 2,600 years, but it is also an encyclopaedia of the civilization's culture.

In an average volume of 300 pages there are about 15,000 references. The complete dictionary will refer to about 165,000 passages from ancient texts. More than 60 American and European Assyriologists have been associated with the dictionary at one time or other. From 1921 to 1994 they compiled more than two

million cards of transcripts about 100,000 Cuneiform tablets.

In 1956 the first volume of the project was published. It was in the next 20 years by a team of scholars, D. D. I. and S. K. and L. The volume was published in 1975, and volume II will be published next year.

A large part of the work will be spent on editing and preparing the final manuscript, and one or two research assistants.

The dictionary is printed in 1,250 copies a volume. The first 12 volumes cost \$100,000 each, which covers the cost of the text and the cost of the illustrations. The cost of the illustrations has been covered by the university library.

The Hittite dictionary, an ambitious project, will consist of 4,000 entries, and will be published in 10 volumes. The first volume is expected to be published in 1977, and the last in 1994.

Like Akkadian, Hittite was a Semitic language, but it was spoken in a different area, and its script was different. It was first discovered in 1828, and its decipherment was completed in 1857.

There are two more volumes now under way at the Oriental Institute. The first is a dictionary of the Hittite language, and the second is a dictionary of the Hittite literature.

The Institute is also working on a dictionary of the Hittite religion, and a dictionary of the Hittite art and architecture. The Institute is also working on a dictionary of the Hittite science and technology.

Finally, a project that will be of surpassing importance is the reconstruction of the Hittite records of the Hittite empire. The records are now scattered in various museums, and the Institute is working to bring them together.

The only record of the Hittite empire is a list of Hittite kings, and the Institute is working to reconstruct the Hittite empire from this list.

The Hittite empire was one of the great powers of the ancient world, and the Institute is working to bring it back to life.

\$302,900 for Soviet work

The National Science Foundation has awarded a grant of \$302,900 to the University of Chicago to study, translate and publish Soviet works on the theory and use of computers in such areas as economic forecasting, managing large systems and large cities, decision-making and the education of top executives.

The money will support the first year of a planned three-year project in the department of mathematics. About 50 Soviet books will

be translated and published. The project is part of a larger programme of cooperation between the US and the Soviet Union in the field of computer science. The project is being led by Professor Isaac Wirgin, who is a leading expert in the field of computer science. The project is also being supported by the US State Department, which is interested in the Soviet Union's progress in computer science.

Gunther Kloss traces the history of University Framework Law in Germany.

Laying down the law for one and all

The Hochschulrahmengesetz (HRG), the University Framework Law which finally came into operation this January, establishes for the first time a uniform legal framework for all institutions of higher education in the country, in whatever Land they may be situated.

The need for such a measure arose in the late 1960s when, in a somewhat belated response to the numerous demands for internal university reform, the Länder, which are responsible for higher education, began to reform their own universities in different ways.

The first Federal Framework Bill in 1970 was designed both to prevent further fragmentation of the higher education sector and to secure modernization of its institutions which at that time only some Länder had completed.

Controversy

The student protest movement, supported by many liberal-minded intellectuals inside and outside the universities was at its height. There was a widespread feeling that the view of the fundamentals changes West German society had undergone since the war a new relationship between the universities and society had to be stipulated and the institutions had to be reformed.

The Bill set out to do, but it inevitably provoked bitter controversy. The Bill was lost because of the intervening premature 1972 Federal elections. However, the Government produced its second, revised Bill in 1973 the political and social climate, even the legal situation with regard to higher education institutions, had changed.

The enthusiasm for reform was beginning to wane. The process of internal democratization, by which almost everywhere the formerly authoritarian powers of the professors and directors of institutes had been replaced by a variety of models of decision-making involving students as well as junior and often even secretarial and technical staff, had begun to take root.

Now that the senior staff had been deprived of their control, members of decision-making bodies at schools of studies level as well as at university level—saw themselves as "groups" and often were mandated by them.

Stalemate was the all-too-common result, especially if extremist and doctrinaire attitudes persisted. The universities in those Länder which had passed the more "progressive" legislation, especially in Baden-Württemberg, had become the most politicized and experienced the most problems.

In the meantime the Federal Constitutional Court in Karlsruhe had also made a crucial decision as far as decision-making was concerned. Several hundred university professors, supported by the Rectors' Conference and the German Association of University Professors, had challenged certain provisions in the Lower Saxony University (Amendment) Act relating to the voting rights of their group.

New court's ruling gave a definite process. It found that academic staff were not "sovereign" in the sense of the Basic Law, and that at least 50 per cent of votes in all decisions concerning teaching and more than 50 per cent in decisions relating to research and appointments, had to be held by a definite check on what the Germans regarded as the most essential aspect of university reform. It forced a reversal of the original reform legislation.

More conservative and traditional members and civil servants welcomed this decision. The Christian Democratic dominated Länder, in particular, now advocated a return to more "realistic" state of affairs. In addition, the attitude of virulent opposition to the reform movement had by now hardened.

The Federal Government had to stop the Federation encroaching on the Länder's powers in the education field. So they submitted a second, Länder, chamber of the Federal Parliament their own

Bill regulating the staff and salary structure in higher education, thus threatening to make an important section of the General Framework Bill superfluous. This Bill never became law.

Similarly they seized the initiative on this occasion more successfully after a further Constitutional Court Judgment (in 1972) this time concerned with the legality of the numerous clauses, the restriction of access to university for properly qualified grammar school leavers. In order to guarantee the uniform admission standards demanded by the Länder, they rapidly concluded a Central Admissions Office and establishing an elaborate selection procedure.

This is still in force today and again anticipated proposed sections of the Federal Framework Bill. The Federal Government's second Bill was obliged to take account of the developments since 1971. But although it was less reforming than its 1971 predecessor, it was rejected in April, 1975, by the Opposition-controlled second chamber.

This time, however, pressure for reform continued from outside. Despite an enormous expansion programme, the universities were still short of applicants had to be turned away from institutions of higher education. The way in which the Central Admissions Office was under the interstate treaty, required to accept such a large number of applicants was a public concern. Pupils, parents and schools became more and more preoccupied with obtaining good marks as these alone would secure a place. The pressure on politicians grew to higher education institutions, had changed.

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France

A school without permanent staff

Externally, the school is hardly prepossessing. A pseudo-classical portico built in grimy, flaking stone which rises from the busy boulevard des Saints-Pères, a stone's throw from the more fashionable Bd St Germain, into a dim, untidy inner courtyard. Inside too, the effect is neither aesthetic nor functional. Narrow, winding corridors meander between cavernous, high-ceilinged classrooms and cramped and overcrowded offices.

Yet this is the Ecole Nationale d'Administration, the most recent of France's major grandes écoles and the breeding ground for the country's political and administrative élite. This is the school which in 31 years of existence has already produced one President of the Republic, M. de Gaulle, and innumerable ministers and secretaries of state, and has completely altered the administrative approach of the French civil service.

With their ability for solving any type of problem with the same degree of thoroughness, intellectual rigour and objectivity, the graduates (as former pupils are known, sometimes pejoratively) have made themselves a reputation as the white-knives of the French political world and models of technocratic efficiency.

The ENA was the brain-child of General de Gaulle's provisional government in 1945, and was intended to unify the recruitment procedures in the senior ranks of the civil service and diplomatic corps which had previously been left to individual ministries. In addition, it was to provide a closer link between civil service training—democratically in private schools—and the economic and administrative needs of the state.

The school is still financed by the services of the Prime Minister as a civil service recruitment centre. Of the annual budget of 2,525m (€525m), more than 34m francs (€4m) are paid directly to pupils in the form of salaries. All pupils finishing the course are guaranteed a job from a list of vacancies made available to the Government. Most departments ranging from the Ministry of Finance to the prefectural and diplomatic corps.

As at Polytechnique, pupils choose their own subjects according to their final classification. Unlike Polytechnique, however, only 2 or 3 per cent of pupils decide to buy themselves out of their commitment to serve the State for 10 years. By the time pupils graduate as ENA 25 or 26, their ambitions are set upon a specific career. "Our pupils," says M. Chelo, secretary general of the school for nearly 15 years, "are civil servants to the core, down to their very pupils."

In keeping with other grandes écoles, the ENA owes much of its success to the stringency of its competitive entrance examination which ensures a high ability level at intake. Each year, 146 candidates are admitted out of a total of 1,500. In addition, one place is reserved each year for a well-placed graduate from Polytechnique.

The average age of pupils is comparatively high at ENA. The maximum age limit for the majority of civil service recruits is 25 whereas at Polytechnique and the Ecole Normale Supérieure candidates must be under 20.

The Commission believes that some 30,000 students will be denied a place within the next three years if the Government is not prepared to spend an additional A\$105m on technical colleges.

Last May, in a joint budget presented to Parliament, the treasurer, Mr. Philip Lynch, issued financial guidelines to TAFE of A\$73m for 1977, an increase of 7.5 per cent over 1976. It envisaged a minimum annual growth rate of 5 per cent in 1978 and 1979.

The Commission has outlined three options. The first is to cost within the guidelines put forward by the Treasurer. The second is to increase expenditure in the next three years. The second plan envisages an additional A\$63m. And the third an additional A\$103m in the same period. The Commission believes that the

George Morgan looks at the Ecole Nationale d'Administration in the last of three articles on France's elitist non-university institutions

apply between two and three years after obtaining their baccalauréat. The differential is accounted for by ENA's function as an "application school". Pupils are expected to have previously obtained a sound theoretical grounding in common law and economics either at university or in another grande école, generally the Paris Institut des Etudes Politiques. Building on this basis, ENA training attempts to simulate as far as possible the conditions that prospective civil servants can expect to encounter in a wide variety of situations. Emphasis is laid upon a realistic, pragmatic approach. No formal lectures are given, and there are no permanent teachers. Teaching consists entirely in the examination of "real" problems presented by experts drawn from active life.

To broaden pupils' experience both of the public and private sector, several stages or training courses are arranged by the school within the 29-month course. New recruits spend the first 11 months of their training as an "attaché" in a Government office, most frequently in a provincial prefecture. Pupils are assessed at the end of the period by both the préfet and an official from the school. In the second year another stage has to be completed in private enterprise.

ENA's major headache in deciding the content of its teaching has been to foresee the needs of different ministries for recruits with specialized abilities. In 1945, four separate options were open to pupils ranging from general administration, finance and economic social administration and foreign affairs. All pupils, however, were expected to have some knowledge of all the subjects offered and the choice of a speciality did not prevent graduation from choosing a job in another field if his placing at the final classification allowed.

Most criticism, however, has been directed at the school's recruitment procedures which are claimed by critics to be both undemocratic and too heavily biased in favour of Parisian students. There is little doubt that social discrimination does exist and has increased in recent years. Between 1947 and 1954 the professional categories including lawyers, workmen, clerical staff and shopkeepers accounted for 29.8 per cent of pupils at the school whereas the same group in 1970-74 provided only 24.8 per cent. In comparison, the higher executive category increased their proportion of pupils from 24.3 per cent to 37.2 per cent.

Some attempts have been made to counteract this phenomenon by the introduction of a separate "internal" recruitment exam open to civil servants under 30 who have introduced the benefits of a university or grande école education.

President Giscard d'Estaing: a product of the Ecole Nationale d'Administration.

Australia

Government urged to step up technical training

by John Kirkaldy

SYDNEY Australia will have a shortage of skilled manpower unless funds for technical education are increased, the Technical and Further Education Commission warns in its 1977-79 triennial report.

The Commission believes that some 30,000 students will be denied a place within the next three years if the Government is not prepared to spend an additional A\$105m on technical colleges. Last May, in a joint budget presented to Parliament, the treasurer, Mr. Philip Lynch, issued financial guidelines to TAFE of A\$73m for 1977, an increase of 7.5 per cent over 1976. It envisaged a minimum annual growth rate of 5 per cent in 1978 and 1979.

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first will not keep pace with the demand generated by increasing enrolments or fully meet the demands for places; the second will enable TAFE to meet the needs of increased enrolments and the third would enable the standards of facilities in 1979 to be the equivalent of 1974.

Commission chairman, Mr. Keith Coughlan, said: "We need A\$100m more in the next three years if we are to provide the demand. Skilled tradesmen are scarce even now at a time of economic downturn when industry is running at about 75 per cent of its capacity. The need for trained operators, fitters, electricians and other tradesmen will be augmented by the need to retrain many other workers to keep pace with technological changes."

The Commission complains that far too long technical education has been the poor relation of tertiary education. The report talks of "long standing starvation" and points out that in 1973-75, universities and advanced education received A\$4.4 for every A\$1 by technical colleges. The Government's decision to increase funds by 7.5 per cent.

In 1977 was a hopeful sign but "a serious imbalance remains". Last year, technical colleges taught 163,500 students, 42 per cent of secondary students, but received only 21 per cent of expenditure on tertiary education.

The report points out that of the A\$73m allocated for 1977, A\$25m would cover the abolition of tuition fees and represented no increase in actual funds. TAFE has recommended that the states, as follows: NSW—A\$27.5m, Victoria—A\$22m, Queensland—A\$15.5m, South Australia—A\$17m, Western Australia—A\$6.6m, and Tasmania—A\$2.03m.

The commission's report will now be studied by the Minister for Education, Senator John Carr. Government's decision will be announced shortly. It is unlikely, however, that the Government, keen to solve Australia's financial problems by a programme of economic austerity, will increase the funding for technical education much further than its already proposed increase of 7.5 per cent.

more letters. P

from page 1

covered the principles according to which God acted when he created the world. And when these principles were found, the world must be structured according to them. Observations of the reality were not really necessary. The system was based on divine inspiration. If Galileo claimed that he saw celestial bodies or sunspots which should not exist, it was his telescope and not the Ptolemaic system which was wrong.

Under the impact of more accurate observations the Ptolemaic system was replaced by the Copernican system. The real importance of this was not that a geocentric system was replaced by a heliocentric system but that the latter could develop in such a way that it was able to absorb new empirical material, supplied by Tycho Brahe and many others. In the hands of Galileo, Kepler and Newton it became a cosmology which was not primarily based on some philosophical or mathematical principle. Instead it was an empirical synthesis, a summary of all astronomical observations ever made. It led to the discovery of new basic laws of nature, which agreed very well with the observed motions of the celestial bodies and indeed were simpler and even more beautiful than the old laws. But it is important to note that these laws are not sacrosanct. When it became obvious that the Newtonian mechanics were not applicable to the atoms, it was replaced in this field by quantum mechanics.

It took more than two centuries until the victory of science over myth in the field of celestial mechanics spread to the field of biology. In our century the scientific approach has spread also to other fields which earlier were alien to it: such as the origin of life and the functioning of the human brain.

However, this does not mean a complete and definite victory of common sense and science over myth. In reality we witness today an anticentrist attitude and a revival of old ideas. This tendency may have several causes but in a way the most interesting and also most dangerous

threat comes from science itself. And in a true dialectic sense it is the mere triumph of science which has released the forces which now once again seem to make myths more powerful than science.

One of the most beautiful results of science was the special theory of relativity. It was essentially based on the Michelson-Morley experiment and on Maxwell's theory of electromagnetism, which in an elegant way described all the results of the study of electric, magnetic, and optical phenomena. Already when expressed in an ordinary three-dimensional Cartesian coordinate system the special theory of relativity is a beautiful theory, but its mathematical beauty is definitely increased somewhat if it is expressed in four-dimensional space.

This fact was given an enormous importance. It was claimed that "Einstein has discovered that space is four dimensional", a statement which obviously is nonsense. But it had great publicity value. After one or two decades of propaganda the four dimensional world became immensely popular, especially when one learned that the fourth dimension was not time, but time multiplied by $\sqrt{-1}$.

To most people this was impossible to understand. Indeed it requires considerable mathematical insight to understand the deep meaning of it—and still a little more insight to realize that it is mostly mathematical jargon.

Many people probably felt relieved by being told that the true nature of the physical world could not be understood except by Einstein and a few other geniuses. They had tried hard to understand science, but now it was evident that science was something to believe in, but nothing to try to understand. Paradoxically enough, Einstein may have been hailed by the general public not because he was a great thinker, but because he saved everybody from the duty of having to think.

But let us return to the theory of rela-

tivity and its direct impact on the scientists. The four dimensional presentation of the special theory of relativity was rather innocent. This theory was used every day in laboratories, for calculating the behaviour of high energy particles, and such like. As experimental physicists have a strong feeling that their laboratories are three dimensional, and firmly located in a three dimensional world, the four dimensional formulation is taken for what it is: a nice little decoration comparable to a cartoon or a nude at the wall.

On the other hand, in the general theory of relativity, the four dimensional formulation is somewhat more important. This theory is also more dangerous because it came into the hands of mathematicians and cosmologists, who had very little contact with empirical reality.

Many of those scientists had never visited a laboratory or looked through a telescope, and even if they had, it was below their dignity to get their hands dirty. They looked down on the experimental physicist whose only job was to confirm the high-brow conclusions they had reached, and those who were not able to confirm them were thought to be incompetent. Observing astronomers came under heavy pressure from theoreticians.

The general theory of relativity opened an extremely fascinating possibility. Similar to the Earth's surface, which is without borders but still finite, one can in a four dimensional space have a "hypersphere" without any borders and still with a finite volume. This idea was certainly worthwhile investigating.

Einstein's equations allowed a type of solution which gave a universe in a state of expansion. Some of the solutions had a "singular point", meaning that at a certain time the whole universe consisted of one single point only. From this singular point the universe began to expand, so that later all parts of it rush away from each other with velocities which are proportional to the distance between them. These types of mathematical solutions seemed to be applicable to the "expanding universe" which Hubble's famous empirical law describes. The way was now open for a grand new cosmology.

The originator of this was Abbe Lemaitre who called the universe when it was at the singular point *Petite Primitif*. Its great propagandist was Gamow, and the beginning of the expansion was called the "big bang". Neither of them went to the extreme in postulating that the whole universe ever was a mathematical point. The "initial state" was supposed to be a concentration of "all mass in the universe" to a very small sphere. This mass is heated to a temperature of several billion degrees. When this "atomic bomb" explodes its parts are thrown out with relative velocity of light.

This model, which at least from certain points of view was fascinating, was believed to explain the main evolution and the present structure of the universe. In fact it was claimed to predict:

► In less than half an hour after the explosions the elements we find now were formed by nuclear reactions in the very hot and very dense matter.

► At an early time a heat radiation was produced which at the further expansion cooled down and should be now observed as a black-body radiation with a temperature of 50°K. With revised values for galactic distances this temperature should be adjusted down to 20°K. (Through a number of ad hoc assumptions it can, of course, be reduced still more.)

► At a later stage the expanding matter condensed to form the galaxies we observe today.

► The average density in the universe should be at least 10^{-30} g/cm³. (This value should be corrected for the new determination of galactic distances.)

Only working out the consequences of a model is it possible to check whether it gives a fair description of the real world or not. Hence it was quite legitimate to devote much work to the evaluation of the big-bang model. After nearly half a century of work, time seems now ripe for drawing conclusions about the validity of the model. These are discouraging. The model can obviously not explain a number of phenomena it claimed to account for, and the observations seem not to agree with the theoretical predictions.

(1) It seems impossible to account for the formation of the elements by the big-bang process. Perhaps the observed abundance of helium could be formed but for the other 90 composite elements the observed abundances are wrong by

orders of magnitude. Hence the supposed cosmical abundances do not get the expected support to the big bang (but neither do they contradict it). (2) An isotropic microwave radiation has been detected, which the big-bang cosmologists have baptised "the 3°K body radiation" in spite of the fact that it is impossible to decide whether it is a black-body or a grey-body radiation, and whether it is a temperature without big-bang cosmology, or a grey-body interpretation seems more likely, and this would disprove big-bang cosmology. However, it is excluded at present that it is a black-body radiation. If this is so, the isotropic radiation which is expected in spite of the fact that it is expected a radiation with about a thousand times higher energy density. (Of course, it is easy to introduce ad hoc effects to explain the discrepancy.)

In reality, they claim that the age of this very "cold" radiation proves the temperature of the universe was 10 billion degrees (at $t=0$), an inflation over more than nine orders of magnitude. This extrapolation among many other things, that the state of the universe at $t=0$ after the big bang with such a temperature that we can exclude that radiation has been produced here. It should be noted that there are no other explanations, and that there are a number of celestial objects (quasars etc.) which release enormous energy which the big-bang cosmologists claim to understand.

(3) The universe as we see it is obviously not homogeneous, as big bang requires consists of a multitude of galaxies. These must be formed at some arbitrary stage of the universe, but no acceptable theory of the formation of galaxies has been derived from the big bang model.

(4) Even if it can be claimed that the metagalaxy once was less than, say, $4 \cdot 10^{27}$ cm. But this is

A new identity for science

The Magnus Pyke column

Science means different things to different people. It may not, however, be unduly fanciful to argue that we are witnessing a change in the meaning of science as it is recognized by the people. Anyone who stops to think is aware that the present is a remarkable age for new understanding of science. For example, it is widely accepted that the day of creation has now been fixed at approximately 15,000 million years when the "big bang" which began all exploded. Also new to our general understanding is the understanding of heredity, the so-called "breaking" of genetic code which, as a minor effect, is leading to our current concern about what sort of monsters genetic engineering may produce.

The discovery of the extensive whole new galaxy visible (it is now word) only from the new X-ray being carried round and round the earth on artificial satellites would alone be enough to satisfy the needs of our ancestors. Our own sense of wonder is perhaps less acute than it once was. Nevertheless, respect for the man of genius who advances our understanding of science has not been lost.

Those who express disenchantment with science, though they are very few, are less numerous than they seem. They appear to be those who know about science and who confuse the scientific understanding that makes a practical end possible with the demands of the community itself that science should be done. To what extent, and to be asked, should scientists and engineers be blamed for designing and constructing a refrigerated vehicle capable of transporting the thousands of

galaxies are "local" phenomena which need not necessarily be included in a large-scale cosmology. It is more difficult to neglect the existence of large, sometimes very large, clusters of galaxies. Most embarrassing is that the distant quasars ($z = \Delta\lambda/\lambda$) are located exclusively in two regions, one near the galactic north pole and the other in the south galactic hemisphere. Hence the large-scale isotropy of the universe, a cornerstone in the big-bang cosmology, is contradicted by observations.

(5) The mean density in the universe is, according to observations, 10^{-30} , a factor of almost 100 too low. Intense efforts have been made to find the missing 99 per cent ("black footballs" and "black holes" have been suggested) but there is no support—rather counter-indications—of their existence. (Revision of galactic distances changes both the theoretical and the observational value but does not decrease the discrepancy.)

(6) The validity of Hubble's law cannot be counted as a support of the theory, because of an infinity of possible mathematical solutions the one was chosen which fitted Hubble's law. Recent results, however, make it doubtful to what extent Hubble's law really is valid. An increasing number of flagrant deviations from its linearity have been reported. This is serious to the big-bang model.

There are regions of galaxies with red shifts systematically different by 20 per cent (Vera Rubin). Furthermore, there are pairs of galaxies with vastly different red shifts, which seems to show that there are other galaxy populations not obeying Hubble's law. This is fatal to the big-bang model.

(7) The Hubble diagrams no doubt show that the metagalaxy-universe is expanding, which means that at earlier times the galaxies were closer together. But it is not legitimate to conclude that observations show that once all the galaxies were formed by one big lump of matter. With the uncertainties in the measurements one can only conclude that the metagalaxy once was less than, say, $4 \cdot 10^{27}$ cm. But this is

chickens demanded by the citizens for the cracks in the cathedral which develop after the so-called juggernaut has passed close by along a roadway designed for medieval traffic?

Perhaps the identity most commonly attributed to science today is that of an omnipotent provider. If the world's food supplies are considered to be deficient, science must be called in to develop a wonder cereal, an artificial protein or manna from petroleum. Should a new disease—poliomyelitis for example—smite our children, science must provide a vaccine (and it does). If we run short of coal and the Arabs cut off the oil, science will supply breeder-reactor power stations.

It is this image of science that can now be seen to be undergoing a change. The high yields of grain and the accelerated growth of pigs may, with the aid of science, produce a glut but do not necessarily feed the hungry. As Lord Ashby showed in his *Second Look at Doom*, the computer's mathematically impeccable forecast of the future may be far wider maintaining its old identity, make provision for understanding or misunderstanding between a ruler of a nation supplying some particular raw material and a Kissinger or a Croissant. The new identity for science shows it to be still important but not all-important.

The study, zoonoses, that was initiated by the agriculture section of the BA and which is still in progress reflects in what way our first sight could be thought to be an odd way on the place of science in ordinary life. Zoonoses are diseases of animals that affect people.

Scientific methods in the past have been strikingly effective in benefiting both people and animals. The rigorous elimination of cows suffering from bovine tuberculosis combined with the pasteurization of bulk milk supplies improved the health of cattle and saved children from tuberculosis of the bone.

The initial task of the expert group which is now at work is to consider how salmonellosis—what most people would call "food poisoning"—could be stamped out. Salmonellosis, although not among the most lethal conditions, is, as there are all too many witnesses to attest, a widespread nuisance not without dan-

ger to its sufferers. It is eminently sensible, therefore, that the scientific study group should choose it for their initial investigation before all other zoonoses.

Rabies is also a disease of animals affecting people. Although it is a dreadful pestilence it has been calculated that in France, where it is endemic, the chances of dying from rabies are less than that of being struck by lightning. It is at this point that the scientist, concerned with the mechanism of rabies—or of salmonellosis or possibly the common cold—must abandon his special claim to expert status when the time comes to decide how much effort a sensitive community should deploy to cope with rabies or to rescue a single-handed yachtsman in distress while traffic casualties litter the roads in their hundreds.

In an age when, after the best part of a century of compulsory education, it is found that substantial numbers of the population are illiterate, it is not surprising that many people, whose formal education was scanty, have little idea of the underlying principles of science.

How can they therefore expect to be able to judge the science news they read in the papers or hear or see on the radio and television. Can they even be expected to pay any attention at all to science as presented in the media? Often the answer to this question is no.

Dramatic news items on such topics as heart-transplant operations or flights to Mars have little connexion with science any more than does the Loch Ness monster or unidentified flying objects. It could be argued that reports of science itself, like those about economics or church affairs, are only of interest to aficionados of each separate topic. But perhaps this is not true. Science, like crossword puzzles in the newspapers and quiz programmes in broadcasting, is inherently fascinating to the ordinary citizen as an extrapolation of his everyday experience.

It is often hotly debated in scientific circles whether in communicating with the public a scientist can legitimately be entertaining. There may be no clear answer to this question since it depends on where the line between triviality and entertainment is drawn. What is in little doubt (because the viewing numbers show it to be so) is the enchantment which the basic phenomena of science holds for ordinary people.

Similarly, the big bang represents only one of an infinite number of possible solutions. If we insert the observed average density of the universe the result is an essentially "flat" space. This means that according to observations the "universe" we observe could be treated essentially with ordinary three-dimensional geometry (of course, using the special theory of relativity, here as in the laboratory). But accepting the observational result means that the general theory of relativity loses its place as the foundation of cosmology.

On the other hand, what the big bang cosmologists tell us is that once the entire enormous universe was compressed into one small ball.

The way the cosmological discussion has been conducted during the last decades will make many people believe that any criticism of the big-bang cosmology necessarily is a support of the "steady state" or "continuous creation" cosmology. Such support can certainly not be deduced from the present analysis. As is now generally realized, the continuous creation cosmology is in a decisive way irreconcilable with observations. However, much of the objections against big bang which the advocates of the steady state theory have presented are correct.

As the big-bang hypothesis is unacceptable, the question arises of what other hypothesis we should have instead. The answer is simple and straightforward: none.

The big bang is a myth, a wonderful myth maybe, which deserves a place of honour in the coliseum which already contains the Indian myth of a cyclic universe, the Chinese cosmic egg, the Biblical myth of creation in six days, the Ptolemaic cosmological myth, and many others. It will always be admired for its beauty and it will always have a number of believers, just as the millennial old myths. But nothing is gained if we try to place another myth in the place which the big-bang myth occupies now.

The reason why so many attempts have been made to guess what was the state

several billion years ago is probably the general belief that long ago the state of the universe must have been much simpler, much more regular than today, indeed so simple that it could be represented by a mathematical model which could be derived from some fundamental principles through a very ingenious thinking.

This belief probably emanates from the old myths of creation. God established a perfect order and "harmony" and it should be possible to find which principles he followed when he did so.

Accepting that it is just as likely that in the past the state of the universe was essentially as complicated as it is today, how should we approach cosmology? Obviously in the same way as we have guessed the first man did before any prophet had invented a myth. We should try to clarify the present state of our close surroundings, and from that proceed to more distant regions and to successively earlier epochs.

To try to write a grand cosmical drama leads necessarily to a myth. To try to let knowledge substitute ignorance in increasingly larger regions of space and time is science. But we must always keep in mind that the further we proceed from here and now, the more hypothetical, the more speculative, will our description of cosmos necessarily be.

Of course, we should try to reduce speculation as far as possible. But to eliminate it altogether is impossible—and perhaps not even desirable. Of decisive importance is that the approach is empirical, not mythological. The difference between science and myth is the difference between critical thinking and the belief in prophecies: it is the difference between "De omnibus est dubitandum" (Everything should be questioned (Descartes)), and "Credo quia absurdum" (I believe because it is unreasonable (Tertullian)).

The author, Nobel Physics Prize winner in 1970, is professor of plasma physics at the Royal Institute of Technology, Stockholm.

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No.2.

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HIGHER EDUCATION SUPPLEMENT

BRITISH ASSOCIATION

Assessment of risk

by F. R. Farmer

In recent times there has been a considerable increase in risk—risk of being hurt, risk of calamity even elsewhere (Sovets), risk of harm to the environment, risk of sabotage or war.

Those of us associated with the development of atomic energy are particularly aware of the possibility of causing harm through the release of radioactive material. We were led to believe that radioactive hazards were of a very special type which could not be seen, could affect people after 10-20 years, and could affect the next generation.

In 1955 at the first "Atoms for peace" conference, it was said that "radioactive poisons are more hazardous than chemical poisons by a factor of 10^6 to 10^9 ". As a generalized statement, this is untrue, as is the description of plutonium as "one of the deadliest substances known to man" in the *Cochran* recent book.

The weight of plutonium likely to cause death within one year is one-tenth of the weight of chlorine which could cause death quickly. Furthermore, if a linear dose-effect relationship is applied for plutonium, then one-thousandth of the amount—about 1 microgramme—would give a risk of 1 in 1,000 of late cancer.

Other spokesmen in 1955 gave various estimates of the result of a serious reactor accident: a range of 200/500 deaths in a lightly populated area, or up to 3,000, according to another report. By implication this posed a greater threat than other industrial activities, although this is now questionable.

I have introduced the discussion of risk through my experience in atomic energy not in defence or attack, but to show the difficulty in describing the nature or size of risk in complex situations. In the early development of atomic energy, in some licensing procedures, the idea of a maximum credible accident was introduced, perhaps in response to the questions, "How bad can it be?" "What is the worst that can happen?"

If this question were to be applied to the introduction of a jumbo-jet, the answer might be 350 deaths; but two could collide—less likely—causing up to 700 deaths. Even worse, the plane could crash into a football stadium—the death toll might be many thousands. We might regard this as so unlikely—a risk of less than 10^{-7} per year—and accept the maximum credible accident as lying between 350/700 deaths.

In many other risk situations the assumptions are not obvious. Consider the release of a toxic gas. Individual consignments of tons of tons are regularly carried around the country. An accident may only release a small quantity, the release rate might be limited by the escape hole size or the supply of heat; the accident might occur in open country or in a populated area; the wind may be weak or strong, toward or away from population. Remedial measures might be effective or not.

Is the worst result, the number of lethal doses carried? Such a number has been quoted for plutonium—there are 10^6 potential lethal doses of 1 mg in 10 kg—on the same basis there are 10^6 potential lethal doses of 1 mg chlorine in one ton. These numbers certainly give an upper limit, but it is impossible to subdivide into 10⁶ doses to give to 10⁶ people; the result is not merely incredible, it is impossible.

Is there a lower limit which has some useful meaning? I have not found a way of describing a potential risk by a single figure, a range is somewhat more helpful. Butane, propane and other like materials are widely used in quantities from kg to hundreds of tons. They can burn vigorously or explode. On an average, explosive accidents kill about one person per ton, but the range is at least one order of magnitude about the mean.

There have been many small releases of toxic gases, often without causing death; chlorine is widely used and transported, and very few have been killed in 50 years, but the release of 10 tons could kill a few hundred people. So, to describe the risk it is not enough to quote a specious upper limit, it is necessary to indicate the degree of probability of the result.

An accident which could kill is deemed sufficiently improbable activity which could lead to it is accepted—usually by decision as incredible. I believe not generally recognized that small possibility of accidents has serious consequences—and the situation is neither accepted nor denied.

Most experience of social activities carrying a risk is from the past 30/50 years and that standards are improving. In this trend is the large increase in quantity of potentially hazardous material in store, process and use, an increase of at least a factor of 10 in the chemical and petrochemical industries.

Do we now need to achieve standards by an order of magnitude to reduce the risk of accidents by orders of magnitude? We need to employ more rigorous analysis and the better use of present experience in the assessment of risk—but to what limit of ability?

We return to this question. I introduced this discussion in reverse order to the way we use risk. There are many types of risk, a distinct difference between a sequence (Flintborough, Severn) more random type of accident occurs at home, at work, on the road.

These accidents will kill more people than the dramatic event. 22,000 people in the United Kingdom died from accidents; 7,000 a year per cent over age 65. The accident rate for the working population, at about 5×10^{-6} per year, may be slowly improving.

Are we more concerned about the chance of a catastrophe killing hundreds in the next 10 years? Accidental death of over 200,000 within 10 years? They are not amenable to analysis and measurement. The manufacturer could be stopped.

Action to reduce death at work requires change in design, attitudes of management and such attention to detail as likely that the risk rate will fall slowly, perhaps a factor of 10/20 years.

If we live in a society accepting an accidental risk of the range 10^{-7} to 10^{-8} per person, it is reasonable to allow current conditions to continue or new ones to be introduced arising from a severe accident is even lower, say 10^{-10} per person.

It is fashionable to propose a benefit analysis. I suggest this is helpful in very simple comparisons. Naturally to accept any risk would like to be assured of something, but even employment is a bet. It is possible that many of the commodities and associated processes would not have passed benefit analysis. The widespread use of petrochemicals and many new materials (as chlorine) have brought benefits in reducing accidents from fire and in improving our standard of life and life expectancy.

I cannot usefully join in a balance of risk versus benefit. There are many risk-associated activities accepted and others proposed, decisions will need to be taken. Then, need to assess the nature of risk, the range of possible consequences and a best analysis or judgement (worked word) of the chance of accidents at various levels of severity.

Work in this field is making progress and it is important that should continue, recognizing that ability will be much affected by conditions, by the degree of risk in the analysis, in the projects, in the management and supervision.

Mr Farmer is safety adviser to the *Magdalen Atomic Energy Authority*, Chesham, Warrington.

BRITISH ASSOCIATION

Light at end of the line

by C. P. Sandbank

In the world of science fiction, one of the most common conventions is total, instant communication. For the man on the moon, two-way video contact with the earth is a matter of course. For the man at the end of the line, every kind of service at the touch of a button, access to computer banks, to data, to any, education, information and communication other than the spoken word, is a matter of course. In the home, an instant shopping list can be sent by computer.

Many years ago, the novelist E. M. Forster described a decadent, futuristic civilization living an anti-life underground existence, kept alive and intelligent by total electronic communication. In his story *The Machine Stops*, the technologies which would make such a situation possible (although hardly welcome) were not invented when he put pen to paper. Today we are close to being able to create the communications for such a world, should global disaster ever make it necessary.

How can this be, when telephone lines are often overloaded, when the airwaves are so densely packed that there is a queue of users awaiting frequency allocations.

The key lies in an idea first put forward by British researchers 10 years ago at Standard Telecommunication Laboratories, the International Telephone and Telegraph Research Centre at Harlow in Essex. These men, led by Dr Charles Kao, suggested that glass fibres carrying light signals from lasers could replace wire systems in wideband communication such as the telephone network.

There was nothing particularly novel about the idea of guiding light along glass fibres. A study of "dielectric waveguides", such as glass rods, had been made in 1910; John Logie Baird, the accredited inventor of television, had taken out patents in the 1920s as have other scientists since. The medical endoscope, probe, had been in use, since the early 1950s.

What was significant about Kao's idea was the proposal that guided optical waves could be used for very large information content communication over long distances. In a paper published in 1966 Kao and Hockham analysed the conditions required to fabricate optical fibre waveguides which would allow a modulated light wave to transmit high frequency signals between distant locations without the information getting lost due to absorption or distortion of the signal on the way.

The group at STL suggested that within a few years the infant technology of semiconductor lasers would marry up with great improvements in the transparency of very pure glass, making possible a system where cables containing glass fibres could economically take over from metal wire communication with much greater information carrying capacity than conventional cables. If these assumptions were correct it would herald a revolution in landline communications, and might also free some of the broad-band frequencies for expansion of more sophisticated "mobile" services.

In a basic electrical telephone system the original signal, the human voice, is converted into electrical pulses via a microphone, and these pulses are transmitted along conductor wire. Every two kilometres or so throughout its journey the signal has to be boosted by an amplifier. It is switched, through electro-mechanical exchanges, and eventually is received at the other end and converted back into a human voice by the telephone receiver.

That system has not changed in principle since Bell invented it 100 years ago. It has become more sophisticated over the years, however. The quality of transmission now generally makes voice recognition possible. Many telephone calls can be coded together on one wire. The latest undersea system, for example, can transmit over 5,000 calls along one two-way cable.

Smalling codes, from the simple ringing tone to complex international dialling signals, are all incorporated. Computer data, television and other signals can be transmitted through the ordinary telephone network.

Glass fibres were examined, of course, along with other methods, but the weakness at that time was the inability of the glass to contain a decent signal for more than a few metres. To realize the kind of clarity needed for a useful system you would have to imagine a window with a pane of glass two kilometres thick through which you could see perfectly. The research work at STL led to a



Fibre optic cable could revolutionise telephone, television and other communication services in next 20 years

the fanciful sun which threatened James Bond's life in the film *Goldfinger*. Certain types of laser can be made to cut through steel or concrete, but the semiconductor laser is very different. It is grown in crystal form in compound, of the element gallium, then divided into thin chips, each not unlike a multi-layered sandwich. When the pulsed electric current is passed across the laser its effect is compressed into the central layer, where the light is generated and emitted, confined in an intense, near-parallel beam.

The laser is built very precisely against the end of the fibre. Once again, an appreciation of scale helps: the single laser chip is barely visible without a microscope. For handling purposes it is mounted in a brass terminal stud to which the fibre is attached.

In the ultimate system, the laser would emit its light into a fibre with a core diameter of only three microns (three thousandths of a millimetre). As three microns is the wavelength of near-infrared light this means that a perfect single lightwave would travel along the fibre. Such a pure signal could carry 150,000 telephone calls.

Research work is now mainly concerned with the mechanics of systems—joints, splices, connectors—and the development of optical techniques for switching and amplifying the signals. A number of components and small systems are being sold for evaluation and trial purposes.

In September, 1975, Britain became the first country in the world to have a fully operational optical link installed other than for trial purposes. This was commissioned from I.T.T. earlier in the year by the Dorset police, to provide a link between their computer and the control room video display units. Its installation demonstrates one of the important advantages of optical communication.

The fibre is totally immune to electromagnetic interference and the kind of high voltage surges which could be caused by a lightning strike. That, in fact, was exactly what happened to the Dorset police communications centre earlier in the year, causing extensive damage and putting important systems out of action.

Immunity to electromagnetic interference is clearly a big advantage for the optical system. It means it can be used in electrically "noisy" environments such as ships, aircraft, factories and computer systems, providing interference-free communication without costly insulation. But it is only one of many advantages.

We have already described the main asset—a huge traffic capacity in a tiny space, relative to present systems. It is as if you could take all the road traffic on the M1 and divert it at high speed, along one country lane, without hold-ups or accidents. Technically speaking it means you could transmit the complete text of The Bible in one-tenth of a second.

This asset also overcomes many of the engineering problems in expanding the network. The optical cable could be pulled into existing Post Office ducts where space still permits or, at worst, present ducted cables could be salvaged and replaced with optical cable, giving much increased capacity.

It means that broadcast radio and television could be shifted to optical cable. This would improve reception and release air-space for the expansion of mobile services mentioned earlier.

Another important asset of optical fibre is that it is made from the world's most common raw materials—silica, sand, silicon and so on, and would free diminishing copper resources for other uses and conservation. Nor would it use great quantities of the stuff. The Post Office has estimated that a cable television system serving 10 million homes in Britain would need about 40 million kilometres of fibre which could be made from only 800 tons of pure glass melt.

More, then, is a system which is neat, small, lightweight, free from most kinds of interference, offering a great deal of increased service possibilities and, an increasing virtue in developing technologies, which is also elegant. There is no exceptional reason why the next 30 years should not bring a complete shift into what scientists technically (and prophetically) call "the optical regime".

Standard Telecommunications Laboratories 1976.

Mr Sandbank is manager of STL's advanced communication systems.

Trials ahead for SRC

by Sam Edwards



The Science Research Council, like so many of our national institutions, is facing difficult times ahead. This is a result of many quite different factors, stemming from both the changing nature of science and the national financial situation. In this article, I shall discuss the problems in both categories, and try to draw some conclusions about the correct strategy for British science in the next five or 10 years.

Financial problems

The most obvious financial problem faced by the council is the reduction in its budget. This is caused in several ways. The first and most obvious one is direct cuts by the Government. Sometimes these descend upon us abruptly, sometimes they take a course which is more or less expected, such as the cuts recently imposed by Mr. Healey.

However, a very much larger cut from the point of view of planning has been the stopping of the growth of the science budget. For many years the science budget, and that of the SRC in particular, had been growing at the rate of several per cent a year, which allowed one to take in one's stride the various increases in expenses which I shall be discussing later on in this article.

However, that stopped a few years ago and after an initial reduction, the growth rate for the science budget is now zero. The next effective cut on our budget follows from the cash limit policy. Under this policy the compensation for inflation will be limited to 10 per cent. This has two effects.

First, internal inflation in Great Britain is more than 10 per cent so we will suffer a cut as a result of that, but perhaps more acutely the SRC pays for a great deal of imported equipment and conducts several operations abroad.

The weakness of sterling has led to an effective inflation rate on these items which is far greater than the normal domestic inflation rate. The cash limit policy therefore has a more severe effect on the SRC than on the other research councils which have a greater proportion of their income going into manpower costs which are not subject to cash limits.

Finally, one comes to the cuts which have been imposed on the SRC in the distribution of funds within the science vote made by the Advisory Board for the Research Councils (ABRC). The ABRC advises the Secretary of State on the division of the science budget and has recommended a cut on the SRC and growth rates for the other councils because it feels that the SRC is supporting several areas of science which are very expensive and which, if closed down, would produce savings which could be more usefully employed elsewhere.

Such a policy can be a deceptively easy way to balance one's books. One looks through a list of activities supported by the science vote and some stand out very clearly as expensive projects which can be stopped. In other areas it is not at all obvious, to see how things can be reduced, other than by just saying that all expenditure must be reduced by x per cent.

In any pattern of science expenditure, some items will inevitably turn out to be far more expensive than others and this comes about in two ways. First, the science which one gains may be of exceptional quality, and the number of active workers in the field is really not relevant, providing that the science finally produced is good enough to justify the expenditure.

The second point is that one is often dealing with a national capability in that responsibility for some area of science has devolved on the SRC and in order to have any activity at all in that area in this country it is necessary to spend some rather large sum of money.

Science tends to be an interlocked activity and when a nation just leaves out a whole area of science it will be automatically demoting itself into a second rank position. Of course if one really is a second rank country, one just lives with that. But if one has ambitions to stay in the top league one does not just rule out a particular area simply because it takes a degree of financial organization to ensure that the appropriate amount of money is available.

The view within the council is that we can no longer afford to run the domestic high energy physics programme and I believe that decision would have been made independent of the ABRC's view since the kind of decision-making required for the United Kingdom to go ahead with accelerators does not seem to be possible within the UK framework any longer. Nevertheless, we shall be able to maintain an activity at the forefront of the field by using the great new machine which is now just coming into commission at the European Centre for Nuclear Research.

However, when it comes to space science the matter is really very different. Here a small number of British scientists has done extremely well and it will be a real tragedy if we are unable to find funds for them to continue. Space science has introduced a completely new dimension into both astronomy and terrestrial science.

The future of this science appears to be bound up with the Space Shuttle and Spacelab which are now being pressed ahead vigorously by NASA, the National Aeronautics and Space Administration, with support from the European Space Agency, and it does seem to me a very high national priority that Britain keeps some kind of presence in this development.

I think really only space science and high energy physics are really big science in the sense of being extremely expensive per scientist involved. There are many other expensive areas of science but nearly all of these have large communities or, in the case of astronomy, for example, employ instruments which, though expensive to build, have an enormously long lifetime and therefore should not be counted as extremely expensive at

all. I believe that if one did an assessment of the cost per creative scientist one would find that almost all science came out at roughly the same price. However, it is undeniable that there is no short-term return in a subject like high energy physics and cutting it is a rather straightforward way to find some money.

The Changing Pattern of Science
Scientific and technological studies inevitably become more complex as time goes by and as more and more phenomena get resolved and more and more complex and ingenious applications of basic knowledge are evolved. It follows that throughout the whole spectrum of SRC support there is pressure for more expensive equipment to keep up with other nations and to respond to the changes that take place within any discipline.

This occurs at all levels; telescopes get bigger and see further into space; accelerators get bigger and can generate higher energies; computers get bigger, control engineers make increasing demands on computer power and engineers in design use computing in an interactive mode which is an extremely expensive though, of course, very effective way of using a computer.

But there are less obvious evolutions within science. Nuclear magnetic resonance machines, which started as fairly modest affairs, have now run to the £100,000 class. X-ray work has gone on for many decades but is now seeing that we can adapt synchrotrons to produce X-rays and produce a whole new era in the speed of resolving structures by X-ray methods.

This produces not only a change in financial requirements but a change in organization. If X-ray crystallographers in the 1950s will be using X-ray radiation from a synchrotron they will obviously have to travel to a central facility; that facility itself will be large with a permanent staff and there will be a corresponding drop in funding of small-scale instruments.

When NMR machines become so expensive that it is quite impossible for each

chemistry department to have its own has to be decided whether they should be provided centrally or should be offered only with the proviso that a service to other universities. In this sense one can believe that in 1980s there will be no more small-scale science. Every design engineer will have his own computer or, alternatively, minimal to a national centre.

It could well be that in the future research lasers will have to be centrally and will reach a level of support but had to be developed in league as big physics. The same pressure will arise in branches of engineering, as marine technology where access to large-scale structures and full-scale testing is an essential part of a research programme.

An additional complication is given the virtual collapse of the Government grant to the University Grants Committee from the Government, accelerating price of equipment, university scientists are going to be modest support from the UGC but this throws an extra burden and responsibility on SRC at a time when budget is decreasing rapidly.

One final change ought to be mentioned in most branches of science, engineering the council can make an effective contribution to the nation's research programme by acting as a resource, taking in applications, selecting them, judging them in accordance with the Government's policy and awarding grants. It is clear that the important fields where this does not work very well.

In polymer engineering, marine technology, the teaching company, and areas, some direct action by the council seems desirable. In these fields it is proved really very difficult for universities and polytechnics to start up a useful operation because of the expense and also because there is a level of competence in industry or applications from universities which, rather amateurish, being a first step at this, get handled very roughly by referees.

Nevertheless, there are several where the higher education system do most valuable long-term research

where it is the business of SRC to see that this research is started. It is important to emphasize that there is nothing particularly new about this in as much as when Britain decided to go into space in 1960s there will be no more small-scale science. Every design engineer will have his own computer or, alternatively, minimal to a national centre.

Similarly, in high energy physics the decision was originally made at a national level to go into this and then resources were found. What is new is that whereas in the past disciplines could not turn to industry for support but had to be developed in isolation, the SRC now has to make some decisions in areas which have previously been developed by industry and not by SRC. Initiatives in areas which have previously been extensively represented in the university sector. We are tending to encourage something which has happened in science for a long time.

This new development means that the SRC is faced with diminished resources and increased responsibilities. We believe that it has found the right way of funding new engineering initiatives; it can see the pattern of support for the sciences for the coming decade, but it is faced with very difficult decisions on how to keep alive the very expensive sciences which seem to have fallen from favour in Government circles.

What we need more than anything else is some kind of stability. One can put forward a rational programme on virtually any budget but if one is faced with budgets that fluctuate wildly it means that there is overwhelming pressure to cancel that which is cancellable irrespective of its merits simply on the grounds that this is the only way of saving money quickly. It is therefore stability which is my plea even more, perhaps, than just straight cash.

To summarize, I would say that the SRC is faced with diminished resources and increased responsibilities. We believe that it has found the right way of funding new engineering initiatives; it can see the pattern of support for the sciences for the coming decade, but it is faced with very difficult decisions on how to keep alive the very expensive sciences which seem to have fallen from favour in Government circles.

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Because its greenness does not change with light intensity we call it "a linear system". (Ohm's Law describes a linear system.)

We now put our paint in a dark cupboard. Does it suddenly turn red, because of the darkness, a redness we can never detect, because, as soon as we use even the weakest light to look, why, snap, it turns fully green again?

Well, we are free to postulate such a redness, if we wish, but some (including me) would say that if we cannot detect it then it lies outside the scope of physics. Physics still rests on its ancient philosophical basis, we still have to choose the simplest description which fits the observations. It is simpler to say that the paint stays green, in the dark, than that it takes on an undetectable redness.

A physical theory, therefore, will be one which admits a continuing greenness, which does not call for an undetectable disappearance. It is a physical theory because it has some basis in observation.

Just as for the greenness of (linear system) paint, so, equally, for other physical parameters (of measurably linear systems), none of these parameters or properties disappear when we are not looking. Yet disappearing trick theories abound.

To the outsider, it seems pointless. Astrology is more reputable. It freely admits it has no adequate experimental basis, and it invites one to accept an admittedly inadequate experimental basis. The part of physics of which I am most proud is that it does not give a damn for experiment. It is mumbo-jumbo, impure but not simple.

Can we manage without disappearing tricks? Well yes, and physics is a lot more satisfying if we do. The symbols become fewer in number and they become more comprehensible as Maxwell would have wished—they stop being "only a coefficient in an equation".

In fields in which we were bamboozled by $O-O-O$ we can, if we wish, see what we are doing. In fields in which we presently have a night minus naught equals a little bit, we can see that there is still scope for improvement. This second field is the one that really matters, and out of several possible examples I shall

Stiffening the fibre

by I. M. Ward and G. Capaccio

The past 30 years have seen a remarkable increase in the use of polymers both domestically and industrially. In many cases, the polymer is formed into a suitable shape with comparatively little reorganization at a molecular level, so that the long chain molecules have no overall preferred orientation and the properties are the same in all directions.

It was very soon discovered that the properties can often be greatly improved, particularly with regard to stiffness and strength, if the initially formed polymer is subsequently stretched so that the molecules are pulled out of their random arrangements and given preferred orientation in the stretching direction. The stretching or "drawing" process as it is termed, is the essence of industrial processes for synthetic fibres such as nylon and Terylene. For polymer films, a two-way stretch is usually imposed to give enhanced properties in all directions in the plane of the film.

The strength properties of these oriented fibres and films are generally very good, and nylon textile yarns are of similar strength to mild steel. Although it is difficult to break a nylon fibre, it is very easy to bend it. The stiffness of the fibre is low, which is of great advantage for textile applications. The low stiffness of conventional textile fibres is a disadvantage in applications where distortion to occur under load. This is the case where the fibres are used for reinforcement as, for example, in the structure of a building.

During the past few years the possibilities of using oriented synthetic fibres as reinforcing elements in composite material, have stimulated much industrial research, particularly in the United States. A successful approach has been to synthesize new polymers, which have chemical structures rather like a hybrid of nylon and Terylene. The resultant polymers can be wet spun in concentrated sulphuric acid and stretched to give very stiff fibres indeed, comparable in some cases to steel fibres. The development of such materials is a splendid technological achievement, although the cost of manufacture, as perhaps might be anticipated, is rather too high for their widespread application at the present time.

From an academic viewpoint, the remarkable feature of these new materials is their high stiffness and the fact that this approaches the value expected on the basis of theoretical calculations. Looked at another way, the pertinent question is "why do we never achieve high stiffness in conventional polymers such as polyethylene, nylon or Terylene?"

To fix our ideas, the theoretical stiffness of a fully oriented polyethylene fibre should be similar to that of diamond or carbon fibre whereas conventional industrial processes produce material which is more than an order of magnitude less stiff. It can be concluded from this that the drawing process is not very effective in orienting and unravelling the long chain molecules. In fact the degree of stretch or draw ratio, as it is termed, only amounts to extending the initial material by a factor of between four and ten at the most. Another important question to be asked is "what limits the draw ratio or stretch?"

With these considerations in mind, an extensive research programme on the fabrication and properties of oriented polymers was started in the physics department at Leeds University in 1970. There were two parallel projects, one on the drawing and the second on extrusion under hydrostatic pressure of a range of crystalline and amorphous polymers. Polyethylene was chosen as the first polymer to be examined because of the extensive knowledge of its structure and properties. There was also the prospect of achieving very high modulus as indi-

cated by the exceptionally high value of its theoretical stiffness. This observation of high theoretical stiffness also suggested a very simple way of monitoring the effectiveness of any fabrication procedure by measuring the stiffness (Young's modulus) of the resultant products.

The preliminary studies were carried out on fibre monofilaments produced by a micro melt-spinner which is capable of processing as little as 0.5gm of polymer. The filaments were subsequently drawn in a laboratory tensile testing machine.

It was possible to examine samples with very well defined chemical composition, and the results suggested first that the resultant Young's modulus was uniquely related to the draw ratio for optimum drawing conditions and second that the molecular weight characteristics (the average length and distribution of lengths of the molecular chains) were vital factors in determining the draw ratio. Further studies showed the importance of the initial crystallization procedures before drawing and the influence of draw temperature and rate of draw on the process and the final products.

With appropriate selection of all these factors—molecular weight, initial crystallization treatment and drawing conditions—it was found possible to achieve draw ratios as high as 40 times, and Young's moduli of 10 million psi, which is a stiffness the same as that of glass or aluminium, and very close to the theoretical modulus of polyethylene. Similar results were obtained for fibres and films.

In collaboration with the department of mechanical engineering, the hydrostatic extrusion programme was also successful in producing bulk samples with very comparable properties. Further collaborative efforts, this time with the department of textile industries, have succeeded in the development of a small-scale pilot plant to provide monofilaments at production rates of several hundred feet a minute.

In addition to these more technological achievements, efforts were turned in two other directions. First, there was the recognition that the high draw ratio produced materials with properties close to that of an ideal polymer single crystal for fundamental studies. The key structural factor is the destruction of the conventional lamellar texture where the molecules fold back on themselves at regular intervals to form a 'Chinese cracker' pattern in space. Not only do we now have very high average orientation but also the molecular chains are fully stretched out.

Secondly, although high modulus was used as the key parameter to define the effectiveness of the fabrication procedures, other properties are equally interesting and valuable technologically. These include low permeability to gases, very high resistance to chemical attack, high transparency, the ability to remain deformed when bent (dead-fold) and a high thermal conductivity. In these last two characteristics we are beginning to see properties which have hitherto been associated with metals rather than polymers.

Recent extensions of the research programme suggest that the guide-lines established for polyethylene will be relevant for other polymers. It has already proved possible to make ultra-high modulus polypropylene and polyoxymethylene. These polymers have higher melting points than polyethylene and, although they are not so stiff, their strength and general mechanical behaviour may be superior for some applications.

In conclusion, it should be emphasized that, apart from its obvious technological implications, this research has excited interest primarily because it has removed an apparent barrier from the full realization of the possible properties of polymers. It has been demonstrated that orientation processes into materials with a whole range of new properties. This is another step in expanding the base of polymer science, and illustrates an excellent coincidence of interest between academics and technologists.

(The research programmes described are supported by the Science Research Council and the National Research and Development Corporation.)

Professor Ward and Dr Capaccio are in the department of physics at Leeds University.

Look at the Emperor

by Ross Hesketh

James Clerk Maxwell once said that if mathematicians would take the trouble to put their equations into words they would gain in understanding. Not a popular sentiment, either then or now. Maxwell lumped himself among "us laymen", as one who would profit from the taking of such trouble.

Theoretical physicists continue to praise God upon the symbols. The verbal continuo is in general lightly scored. Could Maxwell be right? Would a fuller sound be more often physically sound? The classic paper (L. Onsager writing in the *Physics Review*, 37, 405 of 1931) in a subject which is well established in the curriculum of physics and chemistry, and which is growing in popularity in the undergraduate curriculum, has at its centre the equation $O = O$. This equation, subjected to mathematical analysis, proves a result which up to that time had been only an axiom.

Are we now further forward? Modern textbooks say we are. The proof is called transcendental. I nod agreement. After all, I am happy with the axiom, and the equation is harmless.

The trouble really starts when we read "as a reasonable approximation, naught minus naught equals a little bit." Then there are really in the grip of the symbols. Perhaps the equation $O = O = O$ was not so innocuous after all, it had a soporific effect. We liked the sound too much. No discussion? Very well, discussion.

At each stage I mutter "it well it can't get much simpler." And it does. A year ago I said "well at least we must agree about Ohm's Law—and we didn't."

You must realize, Hesketh, that science does not consist of absolute truths. It is essentially consensual. It is a view,

held by a body of people, and it is formed by discussion.

Clearly I was to follow tradition. I have therefore gone out quickly, and without compulsion put my simple question to 520 teachers of physics, in university departments, thus: does the electrical conductivity of an Ohmic conductor continue to exist when the conductor is in complete thermodynamic equilibrium?

It looks a permissible question: Ohm's Law is taught at O-level and equilibrium thermodynamics is in every undergraduate syllabus. The response has been excellent, one in three. So much for tradition. Of every 10 replies, seven say yes, one says no, one thinks the question meaningless and one abstains for a variety of reasons. The replies have two aspects, the social and the scientific.

Socially, heads of departments are considerably (the adjective specifies a difference at the 1 per cent probability level) more willing to answer than any other professors; and very much (a difference at the 0.1 per cent level) more willing than are non-professional faculty.

Among the sub-fields of physics, the proportion of yeses rises to 84 per cent for physicists specializing in the solid state, but sinks to 46 per cent for thermodynamicists. The number of replies is sufficient to say that there is a recognizable difference between the two groups, at the 5 per cent probability level. These are the two groups most closely involved, clearly, in the question.

The difference has a social connotation, and properly use experts to referee papers submitted to them. If experts approve, publication follows. If experts disapprove (and a fortiori if several experts disapprove) publication is banned. Moreover, the ban is non-local, for the invisible colleges span the world.

In the present case, the college of metal physics would give thumbs up to the answer "yes" but the college of thermodynamicists would be likely to give for the answer "no". Now this is very strange, from practically any thermodynamic person to person in quite general form. Thus the extent to which thermodynamicists give "no" answers is a measure of

the extent to which (linear irreversible thermodynamics is widely misunderstood and misapplied).

Socially then, an adherent of the college, perpetually confronted by second, has only one recourse—appeal a wider audience.

So far as I can tell, the physics profession is as powerless to deal with this between its colleges as was the church. Perhaps the continuity of physical properties is more susceptible to experiment than was its flogus, but two issues are otherwise remarkably similar, and capable of exciting a response.

Socially again, the "yeses" are very much more confident than "nos", measuring confidence by a statistic to stand up one thing and the pretention of statistics is a very different thing, but would it be wildly unfair in this lack of confidence of the most element of "because a man told us, "No" is what thermodynamicists teach.

The inquiry was open ended, in that it invited letters of reply as well as ticking of boxes. Half the replies were letters. From these, and from the numbers, one can see departmental preferences.

If pressed to put into action a plan to cut some universities so that only might live, Dr Hunter, the vice-chancellor of Birmingham, would doubtless reverse alphabetical order. The plan would be rough, but in regard to physics departments he could do worse.

A last social aspect: the most ardent advocates of the consensual method are immediately condemned the whole class. This seems to be dynamic conservatism. The establishment, any establishment, is not an inert lump, different from the rest because it is big, it is an organism which fights tooth and claw to stay in its. Merit in the present enquiry is not only by outsiders. Simpler than Ohm's Law is green paint. We shine light on it and in terms of wavelengths of absorption we measure it to be green. We make it light strong. It is just as green. We make the light so weak that our instrument barely registers. It is still just as green.

Because its greenness does not change with light intensity we call it "a linear system". (Ohm's Law describes a linear system.)

We now put our paint in a dark cupboard. Does it suddenly turn red, because of the darkness, a redness we can never detect, because, as soon as we use even the weakest light to look, why, snap, it turns fully green again?

Well, we are free to postulate such a redness, if we wish, but some (including me) would say that if we cannot detect it then it lies outside the scope of physics. Physics still rests on its ancient philosophical basis, we still have to choose the simplest description which fits the observations. It is simpler to say that the paint stays green, in the dark, than that it takes on an undetectable redness.

A physical theory, therefore, will be one which admits a continuing greenness, which does not call for an undetectable disappearance. It is a physical theory because it has some basis in observation.

Just as for the greenness of (linear system) paint, so, equally, for other physical parameters (of measurably linear systems), none of these parameters or properties disappear when we are not looking. Yet disappearing trick theories abound.

To the outsider, it seems pointless. Astrology is more reputable. It freely admits it has no adequate experimental basis, and it invites one to accept an admittedly inadequate experimental basis. The part of physics of which I am most proud is that it does not give a damn for experiment. It is mumbo-jumbo, impure but not simple.

Can we manage without disappearing tricks? Well yes, and physics is a lot more satisfying if we do. The symbols become fewer in number and they become more comprehensible as Maxwell would have wished—they stop being "only a coefficient in an equation".

In fields in which we were bamboozled by $O-O-O$ we can, if we wish, see what we are doing. In fields in which we presently have a night minus naught equals a little bit, we can see that there is still scope for improvement. This second field is the one that really matters, and out of several possible examples I shall

give only the oldest, the same one that I gave three years ago (*THES*, April 20, 1973).

For 60 years, kinetic theory of gases, has asked us to accept the mathematical equivalent of the three-card trick; we are to believe that the queen really does disappear. As with all good-performances you have to watch closely. Most people just go away.

However, there is a physical theory, somewhat older, which performs no disappearing trick, that of Burbury (*The Kinetic Theory of Gases*, CUP, 1899). Thus while we can say that what is currently fashionable in regard to thermal diffusion in gases is unequivocally wrong, the older work at least has a chance of being right. Fortunately the difference between the two is amenable to experiment.

What I want to do here is to attempt to follow Maxwell's advice and put Burbury's ideas into words appropriate to a newspaper. This is a scientific procedure, a Maxwellian procedure, for I am working from the symbols to the words. My own experience is that Maxwell's advice is sound.

When two gas molecules collide, momentum is transferred from one to the other, in amount proportional both to mass and to velocity. First think of a collision between two equal molecules. Next, think of a collision in which one

of the molecules is slightly heavier than previously, but of the same size. The momentum transfer in this second collision is different; there is an increase associated with the increase of mass, and a decrease associated with the lower thermal velocity of heavy molecules. The increase outweighs the decrease.

Thus one heavy molecule, in a gas of otherwise equal molecules, always exchanges more momentum, in all collisions, than do the equal molecules in collisions among themselves. If the heavy molecule is for ever giving more and receiving more, then its behaviour is more energetic than that of its fellows. I use the phrase "more energetic" both colloquially and rigorously.

Obviously this small momentum difference is in no way dependent on inequalities of temperature within the gas; it does not do a disappearing trick when the gas is at one temperature throughout. Like Ohmic conductivity it stays put.

An alternative picture is possible. A balloon full of gas is squashable; the gas is an elastic medium. The gas which contains one heavy molecule is an elastic medium which is of uniform density throughout—except at the one heavy molecule. Here the density is greater. It is well known that a region of increased density in an elastic medium is a region of increased thermal capacity. Once we say "the gas is an elastic medium" the problem is over. Again there is no disappearing trick. Thermal capacities do not disappear simply because the temperature is uniform. Like Ohmic conductivity they stay put.

Kinetic theory, as presently formulated, contains the most widely accepted disappearing trick, but there are numerous others. All violate a very basic idea, the idea of the continuity of physical properties, the idea of the mathematical limit. In thermodynamics, all disappearing trick theories should be discarded at the first count.

This statement is quite general. Simplicity is there for anyone who wants it. "Non-linear irreversible thermodynamics" is almost as simple. The emperor's robe has many dropped stitches. Its weight need not bear him down.

The author is a research physicist with the Central Electricity Generating Board.

Green, as in grass, is always green.

Why basic research?

by Harry Elliot

"The highest wisdom has but one science—the science of the whole—the science explaining the whole creation and man's place in it." Leo Tolstoy.

In its charter the Science Research Council is charged with the responsibility for supporting research in science and technology in the universities. At a time when this country is faced with the urgent need to improve the quality of its manufactured products in order that they may compete more effectively with those of other nations in the world market the need to advance our technological skills is self-evident, whilst that for scientific research of the purely academic kind is perhaps less apparent.

Why should we use any of our highly skilled scientific manpower to carry out fundamental research when they might be better employed in tackling short-term problems of immediate concern in applied science and technology?

It is probably true to say that if our engineering products were all as good as those of our competitors and 10 per cent cheaper, or were the same price and 10 per cent better, we would be in no difficulty. To achieve this requires no technological or scientific breakthrough; it does require highly competent and imaginative engineers combined with effective management, conscientious workmanship and good labour relations.

If we are to meet the first two of these requirements it is essential that we attract the bright and imaginative brains into engineering and management and one of the arguments sometimes used against academic science is that it lures the brightest and best into pure research and away from the everyday problems we must solve if we are to prosper.

However, a basic difficulty we face at the present time is that of attracting enough young people of the highest

calibre into science in the first place. This is a necessary condition that must be fulfilled if we are to end up with the high grade engineers and technologists we need.

The intellectual challenge of pure science coupled with the knowledge that this is an activity in which this country excels can be a powerful influence in shaping the attitudes and aspirations of young people and in leading them to opt for a science-based career.

There are, of course, reasons other than the immediate national interest for pursuing a vigorous programme of pure research. They are of a more fundamental and long-term significance. At any time there are and will no doubt continue to be problems which cannot be solved using our current knowledge and understanding of the basic laws of nature. No amount of technological or engineering skill can produce a solution to such problems.

In addition to and quite apart from the strictly practical aspects of fundamental research, man possesses an inherent curiosity about his origins, about his place in the universe and about his environment generally. The need to satisfy this curiosity is reflected in the particularly widespread interest in astronomy, which exists both in the student population and the community at large.

This interest is of long standing but it has been much enhanced in recent years because of the developments of the past three decades which have brought about a remarkable change in the science of astronomy and in our knowledge and understanding of the universe. This revolution in astronomy is the result of extending our observations beyond the very narrow range of optical wavelengths available to classical astronomy to include radio, infrared, ultraviolet, X-ray and gamma-rays.

This country has played a leading part in the development of radio astronomy since the end of the Second World War when the subject first got into its stride and immediately revealed a whole new set of phenomena which, amongst other things, provided the long-sought link between cosmic rays and the general body of astrophysics. Ever since its discovery prior to the First World War, the cosmic radiation had been an important but completely isolated manifestation of what were clearly extremely energetic processes taking place somewhere in the cosmos in totally unknown circumstances.

The giant machines at the European Centre for Nuclear Research (CERN) and elsewhere represent the current limits of terrestrial accelerator technology but they are small fry compared with their celestial counterparts which generate cosmic rays. In order to compete with the cosmic accelerators in terms of maximum available energy, a machine of the CERN variety would have to be on such a scale that the diameter of its magnet would be equal to the diameter of the earth's orbit round the sun. By combining data from radio and optical astronomy it was possible to show that one place in which cosmic rays acquire their enormous energy is in the cloud of debris generated by supernova explosions.

The subsequent discovery of the enormous energy releases in radio galaxies and quasars has led to the serious consideration of processes in which an appreciable fraction of the total rest mass of a galaxy is rapidly converted into electrons travelling at relativistic speeds. Of particular importance has been the discovery of pulsars, stars which have collapsed under their own weight to form what is in effect a single gigantic atomic nucleus having a similar mass to that of the sun and a diameter of a few kilometres. These are the so-called "neutron stars" which are rotating at a frequency of several hundred revolutions per second and gradually slow down whilst converting their energy of rotation into cosmic rays and electromagnetic radiation covering the whole spectrum from gamma-rays to radio waves.

These remarkable objects, of which 100 or so are now known, possess magnetic fields which are upwards of a million times higher than anything we can produce in the laboratory at the present time. This internal physics of these objects is a rapidly growing field in its own right and depends on an exotic combination of concepts from nuclear physics, solid state physics, crystal lattice theory and general relativity.

Stars are formed as the result of the condensation of a diffuse cloud of inter-

stellar material, a process which probably starts as the result of a compressional wave propagation through the interstellar cloud. It is only recently that it has become possible through the methods of infrared and millimetre wave astronomy to investigate in detail the physical and chemical conditions in these clouds and thereby the mechanisms of star formation within them. It is now known that the clouds contain quite complex organic molecules, a surprising discovery which may be of significance in relation to the origin of life in the universe.

A good deal is known about the subsequent history of stars once they are formed and a virtually complete biography can be written for some. Their life styles vary widely, with some passing through the spectacular supernova explosive stage which may be followed by subsequent collapse to form the neutron stars we now identify with pulsars.

Others, by virtue of their greater mass at birth, undergo gravitational collapse as for the neutron stars but their mass is so great that the mechanical strength of the gigantic atomic nucleus that constitutes the neutron star is insufficient to withstand the gravitational forces and the collapse continues beyond the pulsar stage.

This leads to a bizarre situation in which the local gravitational field becomes so strong that in general relativistic terms space closes in upon itself forming a so-called black hole. It is called black hole because, once inside, no material or radiation or signal of any kind can escape. The material of the original star has disappeared from our sight, apparently for ever, and all that is left is an intense gravitational field together with any other evidence there may be of other material falling into the hole.

These few examples may perhaps suffice to illustrate how nature provides us with systems in which there exist physical conditions which represent extremes far beyond anything we can hope to produce in the laboratory at the present time. Present in cosmic radiation are particles with energy far greater than anything achievable with terrestrial accelerators; pulsars provide us with an atomic nucleus of macroscopic dimensions and a magnetic field of hitherto unimaginable strength, while black holes have a gravitational field of such intensity that the material contained within them is shut off, perhaps for ever, from our view.

Such extreme conditions enable us to test our present understanding of nature's laws, to generalize them to cover an ever-widening range of physical parameters and to discover completely new and previously unsuspected processes.

Special emphasis has been placed here on the contribution that the new developments in astronomy are making in the identification of new and unsuspected processes occurring in the universe and in the extension of the basic laws of physics to cover extreme conditions that cannot at present be simulated in the laboratory.

However, we can only make progress of this kind in the context of fundamental research as a whole. We did not learn about nuclear fission from astronomical observations and it is unlikely that we will learn much about molecular biology in this way either. Astronomers would have a poor chance of understanding the internal structure of pulsars if they had laboratory-developed concepts of nuclear and solid-state physics.

Peace may or may not be divisible but fundamental research certainly is not. It has to develop on a broad front or, not actually, maximum effort will sometimes be concentrated in this sector, sometimes in that; it so happens that at the present time advance is particularly rapid on the astronomical front.

It is essential to his material and perhaps even spiritual well-being that man should continue his efforts to understand the basic laws of nature. Other-wise he must inevitably lose the struggle to survive, which depends for its success upon his ability to control and exploit the environment in which he lives. To the options open to him must gradually technological horizons close in.

Dr. Elliot is professor of physics at Imperial College, London and a member of the Science Research Council.

BA CONFERENCE

It is a happy occasion when the Lancaster, the Lancashire County Council, the Cumbrian County Council, the College and the University of Lancaster all combine to welcome an assembly of scientists, engineers, and technologists, to pay them a visit on the occasion of the Annual Meeting of the British Association for the Advancement of Science, which takes place at the University of Lancaster from September 8 to 12.

Not quite all of the meeting is at the university. Some of it is held at the town. The main event is the coronation award for the best doctorate, which will go on in the evening as being the only place capable of accommodating up to 2,000 people. The diversity of the programme and some aspects exemplified by the four individuals whom the society has chosen to honour.

First is Sir John Baker, the first distinguished engineer and scientist. He is a member of the Royal Society and for many years director of education in East Anglia and lately chairman of the Schools' Council; the third is Professor Wassily Leontief, an economist distinguished both as a winner of the Nobel Prize and as an American invited by the economics section of the British Association to serve for a year as its president. Fourth is the secretary, Dr Magnus Pyke.

Perhaps the most explosive mass of science to the public of 1976—a mass for which Lancaster may be remembered as time goes by—is that of Sir John, calling for the use of the nation's resources in a deployment of energy by which, and by which alone, the nation's prosperity can be restored.

Ever since its establishment in 1945 the BA has constituted a forum in which the scientific community has attempted to make itself heard by the public. In Lancaster new ground is being broken by the Royal College of Physicians.

In Great Britain, more perhaps than in other countries, the medical world is not so much a closed society as a circumscripted verging on secrecy. No more. Today, led by its president Sir Cyril Clarke, the Royal College is mounting a symposium, under the chairmanship of Dr D. C. Phillips, president of the BA section of biological sciences, which will discuss problems of tissue transplantation, the medical advance which perhaps before all has aroused mixed sensations amongst the public.

Yet at Lancaster, in the fresh public discussion, the Royal College Physicians describes the basic principles that now permit new parts to be put into a patient's body, that is, a foetus (a "little stranger," as the kidney goes) is not rejected whereas, let us say, is.

In recent years a characteristic stimulating feature of a British Association annual meeting has been that up to a third of those attending have been young people. At Lancaster the largest exhibition, in which 600 exhibitors in Lancashire and Cumbria have participated, is called "Schools at the BA." There are some special lectures for young people, a session of "Stump the Scientist" and a Brains Trust.

But, while these special events are admirable, the most important contribution made by a cohort of bright, technically aware children is to make the adults think: think whether the education of science to create material wealth is judiciously done, whether time enough is left for the wonder of science as a light to illuminate the natural universe, whether the education in which science must be taught have a proper part in the life of the citizen to yield a truly rich life. If the education of Lancaster and the British Association can truly profit from currents of thought like these, their efforts will not have been wasted.

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International relations: a science or an art?



Charles de Gaulle visits Moscow in 1966; his demonstration of the continued importance of the nation state caused crisis in the neo-functional approach to European integration.

Stephen George discusses the possibility of reconciling conflicting approaches to the academic study of international relations

ated the world, basing its success on the principles of scientific management.

The objective could then be to produce principles along these lines, which would give American policy makers the same ability to control the international environment as American businessmen had to control their labour force, production process and markets.

But in such a society efficiency is the supreme value, and the expert rules. If one believes that the full and free development of the potentialities of each individual is more important than efficiency, not only will such a society appear repugnant, but also intellectual products will seem unsatisfactory because they will be designed according to different values.

This point is fundamental to my argument because I believe that both the scientific and classical schools are presently undergoing theoretical crises, and that the origins of these crises lie in a loss of confidence in the values which underlay the acceptance of the original theoretical positions.

For example, the neo-functional approach to European integration adopted by American political scientists in the late 1950s and early 1960s experienced a crisis which was Gaullist actions demonstrated the continued importance of the nation state.

However, what I want to suggest is that the subsequent reassessments of the neo-functional approach, the rediscovery of values and of individuality, had less to do with the liberal programme through Congress and seeing it implemented, Johnson did not have the image of a crusader, and his manipulation of the political machine was seen to be manipulation.

But much more importantly, despite Johnson's success with the reform programme, the expected payoff never came. Instead of internal stability came the ghetto riots. Instead of external stability came the Vietnam entanglement.

These were the events of 1965 which were to have the more important effect on the future of neo-functional theory, and on the future of the scientific school generally. As the liberal technocrats' dream turned into a nightmare in the late 1960s, the radical critique of the technological-managerial society, launched by the student movement, gathered its intensity.

It was not the degree of correspondence between neo-functional theory and the progress of European integration which undermined confidence in the theory; rather it was the doubt about the values on which the theory was constructed.

To turn now to the classical school, the central position of the advocates of this approach has been that the subject-matter of international relations is such that it is not amenable to the same social sciences. It is as appropriate to the natural sciences as the achievement of exact knowledge in the sense of predictive theory is not possible in this area. Each situation is unique, and can

only be analysed according to essentially subjective and intuitive procedures.

The only sorts of general laws which could be formulated about international affairs would, on this view, be so general as to be vacuous, or would have to admit of so many exceptions as to be useless. So the only legitimate way to study international relations is the examination of concrete historical situations.

In one sense, then, this position is essentially anti-theoretical. But it does not necessarily imply an empiricist conception of his theoretical scholarship. Theory in the sense of productive laws is ruled out, but theory in the sense of an organizing concept which acts as the basis for the selection of what constitute relevant facts and how a narrative shall be constructed is possible.

However—with a few honourable exceptions, of whom the most notable is E. H. Carr—the historical approach has been predominantly unselfconscious, and committed to the empiricist belief that the task of the historian is to tell the story of what really happened without imposing anything of his or herself on the narrative.

The tremendous difficulty of achieving detachment when writing about events which are contemporary with the writer has led to the convention whereby modern history ends at a respectable distance back in time before current concerns had developed.

There seem to be three types of theory which can be identified in this school. First, there is the theoretical orientation: the theory that the only appropriate ways of studying international relations are through the methods of history and philosophy, with international economics accepted as a third, valid approach, but one which deals with different aspects of international relations, and is therefore not normally considered as part of the same activity of understanding.

Secondly, there is the conceptual framework which, whether the empiricist historians accept or not, must define their writing, acting as an organizing principle. Thirdly, there is theory in the sense of philosophical speculation about international politics.

The orientation towards a humane rather than a scientific approach to international relations was appropriate to the position of English academics. Britain had long experience of international politics at the practical level, and so there were established procedures for dealing with such questions.

There was therefore no demand from statesmen in Britain for an investigation and explication of the principles which underlay international relations, as there was in the United States.

Nor was there the same link between academic work and policy formulation in Britain as there was in the States. Although English academics did become politicized and, *vice versa*, the two activities were considered to be separate and alternative to one another rather than being complementary.

So English academics have, since the end of the war, been able to live a life of insulated security free from any pressure to produce research with relevance to the problems of the country or the world.

Today, however, the economic situation is starting to undermine the prerequisites of the good life. Inflation is starting to give way to trade unionism as university lecturers face the steady erosion of their previously privileged positions.

Government no longer seems prepared to afford the luxury of purely academic research, and there is a new demand for relevance. The consequences of these twin occurrences

is that the classical school also seems to be entering a period of reassessment. I would like to mention two symptoms of this.

First, there are signs of a new wave of theoretical activity. This in itself is remarkable, because by far the bulk of the work in the classical school is historical. The first real wave of theoretical speculation came in the late 1950s, and culminated in the Butterfield and Wright book *Diplomatic Investigations*.

The stimuli for this departure were the Cold War, the scientific enterprise, and American money. But since then, the theoretical side of the classical school has gone very quiet. Only recently has a new initiative been taken, by Michael Donelan and Sir John Elliott, who organized a series of meetings throughout the last year of people who were all clearly more sympathetic to the classical school than to the scientific, but who all felt a need for a re-examination of theoretical issues.

The second symptom of a reorientation is the strong movement towards the study of international political economy. This breaks the principle of disciplinary approaches to international relations, but it has been necessitated by the demand for relevance, because the major problems faced by Britain in international affairs are problems of economic regulation and negotiation, combining politics with economics.

This development is very interesting, and I shall return to it in a moment. But I want to mention one other aspect of the attempt to meet the demand for relevance.

If answers are being sought to practical questions, then it becomes important that there should be close scrutiny of the particular situations to determine their validity before action is based on them.

It also becomes desirable that there should be some possibility of learning lessons from the experience of one state or group of states which can be applied in the case of other states facing similar problems. For the principles on which explanations are constructed need to be made explicit, whereas up to now they have been left implicit, and the utilization of comparable theoretical frameworks becomes important.

From this point of view there seems to be some possibility of the classical and scientific schools moving closer together, as the classical school makes its framework of analysis more explicit while the scientific school abandons its aspiration for exact predictive theory.

Here I reach the crux of my argument. I believe that there is now the possibility of a reconciliation between the two schools, and that such a reconciliation would be a very welcome step towards both of them in bringing them through the period of reassessment which they are now undergoing.

There are other possible grounds for communication than that I have just mentioned. For example, neo-functionalism rediscovered the role of the individual statesmen in the processes of international relations. There could be room here for a debate on the role of the Great Man in history, something which the classical school has made the basis of much of its empirical explanation. At a time when the British have a good deal of reason to doubt whether individuals can control the pattern of events, the two positions of this could well meet in the middle.

But the most important reason for believing in the possibility and desirability of a reconciliation is that the two schools now have much closer concerns. Both are wanting to ask questions about the political economy of the world, and are trying to develop an international political economy at the level of theory. And both are concerned with the normative grounding of a new international order.

International political economy is being pursued on both sides of the Atlantic, and it may prove to be the meeting ground for the classical and scientific approaches. Many people do seem to be pinning their hopes on it. But it will not take us very long if it is seen as just the application of the methods of both economic and political science to selected problems, which lie on the borders of the two disciplines.

If it is to lead to a deepening of our understanding of international relations, then I would suggest that political economy should be an attempt to synthesize the perspectives of the two approaches so as to go beyond either of them and present a new perspective which would recognize the interrelationship of political and economic phenomena.

It should bring out the extent to which international political and economic institutions have been created in accordance with the attitudes and values of the politically dominant powers, and have tended to reinforce a specific balance of power.

And it must address itself to the question of the creation of new institutions and a new order which will be able to win assent from the countries of the Third World, because it will be seen to be a just order.

An older conception of political economy as a normative as well as an empirical inquiry should be brought back into usage.

The author is lecturer in the department of political theory and institutions at the University of Sheffield. A full version of this article appears in the current issue of *Millennium: Journal of International Studies*, published by the London School of Economics.

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Benefits: overseas and children's allowances; free accommodation. Two-year contract. 76 HU 107

Lecturer in Biometry (Sri Lanka)

Postgraduate Institute of Agriculture, Peradeniya Campus, University of Sri Lanka
To lecture in elementary statistics and biometry on common-core courses at postgraduate level.
Postgraduate degree in Agricultural Statistics/Biometry. Candidates with PhD and experience in teaching or research preferred.
Salary: £3,573-£5,409 p.a.
Benefits: overseas and children's allowances; free accommodation; medical and superannuation schemes. Two-year contract, renewable. 76 UU 117

NORTH BRISBANE COLLEGE OF ADVANCED EDUCATION QUEENSLAND, AUSTRALIA

HEAD OF DEPARTMENT OF LIBERAL STUDIES

Applications are invited for the above-mentioned post. The College is developing rapidly as a multi-purpose tertiary institution towards the humanities and social sciences. A projected ultimate enrolment of 5,000 students.
Candidates should hold a higher degree or degree with honours in a relevant discipline, have a substantial and sound knowledge of the liberal studies curriculum, and be able to administer and coordinate the department. They should also have experience in cases in teaching, preferably at tertiary level.
The salary for this appointment will be \$22,445.
Further particulars, curriculum vitae and applications can be obtained from the Association of Commonwealth Universities, 38 Gordon Square, London WC1H 0PF.
Applications, which close on 28 September, 1976, should be sent to the Director, North Brisbane College of Advanced Education, P.O. Box 117, North Brisbane, Queensland 4201, Australia.
WIP 001.

University of Wales

DEPARTMENT OF CIVIL ENGINEERING AND BUILDING TECHNOLOGY

RESEARCH ASSISTANT

with a good Honours degree and subsequent experience or higher degree in soil/rock mechanics or engineering geology to work on geotechnical problems of the South Wales Valleys.
Appointment for 2-3 years.
Research Assistant (Computer Programmer)
duties will include programming on a range of research and teaching projects. Prior experience in civil engineering NOT required. A part-time appointment could be considered.
Salary Range: £2,768 to £3,990
Requests (quoting Ref. 7118) for details and application form to Personnel Section (Academic), UWIST, Cardiff, CF1 3NU.
Closing date: 30 Sept 1976

University of Dar es Salaam

SENIOR LECTURER IN GEOGRAPHY

Applications should be sent to the Director of Studies, University of Dar es Salaam, P.O. Box 35091, Dar es Salaam, Tanzania.
Candidates should hold a PhD or equivalent qualification in Geography, and have at least five years' experience in teaching and research in the field of Geography.
Salary: \$2,768 to \$3,990 p.a.
Benefits: free accommodation; medical and superannuation schemes. Two-year contract, renewable. 76 UU 117

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Closing date: 30 Sept 1976

Universities continued

UNIVERSITY OF THE WEST INDIES

LECTURER/ASSISTANT LECTURER IN THE DEPARTMENT OF PHYSICS

Applications are invited for the above-mentioned posts. The University is a multi-campus institution with a total enrolment of 10,000 students. The Department of Physics is currently expanding its facilities and is seeking to recruit staff to meet this demand.
Candidates should hold a PhD or equivalent qualification in Physics, and have at least five years' experience in teaching and research in the field of Physics.
Salary: \$2,768 to \$3,990 p.a.
Benefits: free accommodation; medical and superannuation schemes. Two-year contract, renewable. 76 UU 117

THE UNIVERSITY OF PAPUA NEW GUINEA (PORT MORESBY)

SENIOR TECHNICIAN, DEPARTMENT OF GEOLOGY

Applications are invited for the above-mentioned post. The University is a multi-campus institution with a total enrolment of 10,000 students. The Department of Geology is currently expanding its facilities and is seeking to recruit staff to meet this demand.
Candidates should hold a PhD or equivalent qualification in Geology, and have at least five years' experience in teaching and research in the field of Geology.
Salary: \$2,768 to \$3,990 p.a.
Benefits: free accommodation; medical and superannuation schemes. Two-year contract, renewable. 76 UU 117

University of Wales

DEPARTMENT OF LAW

Lecturer

(Common Law or Public Law)

Salary: £3,174-£6,446 (1975)

Closing date: 17 Sept. 1976

Requests (quoting Ref. 7118) for details and application form to Personnel Section (Academic), UWIST, Cardiff CF1 3NU.

AUSTRALIA

MONASH UNIVERSITY

DEPARTMENT OF ACCOUNTING AND FINANCE

LECTURERS

Applications are invited for the above-mentioned posts. The University is a multi-campus institution with a total enrolment of 10,000 students. The Department of Accounting and Finance is currently expanding its facilities and is seeking to recruit staff to meet this demand.
Candidates should hold a PhD or equivalent qualification in Accounting or Finance, and have at least five years' experience in teaching and research in the field of Accounting or Finance.
Salary: \$2,768 to \$3,990 p.a.
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AUSTRALIA

Universities continued

ABERDEEN THE UNIVERSITY MEDICAL RESEARCH COUNCIL MEDICAL SOCIOLOGY UNIT RESEARCH SOCIOLOGIST

Applications are invited for the post of Research Sociologist (1978). The person appointed will be responsible for the design and execution of research projects in the field of medical sociology. The successful candidate will be required to undertake research in the field of medical sociology, and to contribute to the development of the unit. The post is full-time and permanent. Salary is £12,000 per annum. Applications should be sent to the Director of the Medical Research Council, University of Aberdeen, Aberdeen, Scotland. Closing date: 15th September 1978.

SHEFFIELD THE UNIVERSITY DEPARTMENT OF BUILDING SCIENCE

Applications are invited from suitably qualified candidates with research experience for the post of Lecturer in Building Science. The successful candidate will be required to undertake research in the field of building science, and to contribute to the development of the department. The post is full-time and permanent. Salary is £12,000 per annum. Applications should be sent to the Director of the Department of Building Science, University of Sheffield, Sheffield, England. Closing date: 15th September 1978.

SHEFFIELD THE UNIVERSITY DEPARTMENT OF SOCIOLOGICAL SCIENCES Special Appointment Lecturer in Sociology

Applications are invited for the post of Lecturer in Sociology (Special Appointment). The successful candidate will be required to undertake research in the field of sociology, and to contribute to the development of the department. The post is full-time and permanent. Salary is £12,000 per annum. Applications should be sent to the Director of the Department of Sociological Sciences, University of Sheffield, Sheffield, England. Closing date: 15th September 1978.

SOUTH AFRICA UNIVERSITY OF NATAL DEPARTMENT OF NATAL DEPARTMENT OF NATAL DEPARTMENT OF NATAL

Applications are invited for the post of Lecturer in the Department of Natal. The successful candidate will be required to undertake research in the field of Natal, and to contribute to the development of the department. The post is full-time and permanent. Salary is £12,000 per annum. Applications should be sent to the Director of the Department of Natal, University of Natal, Natal, South Africa. Closing date: 15th September 1978.

SOUTHAMPTON THE UNIVERSITY RESEARCH FELLOWSHIP

A Research Fellow/Assistant is required to assist in the design and execution of research projects in the field of social sciences. The successful candidate will be required to undertake research in the field of social sciences, and to contribute to the development of the university. The post is full-time and permanent. Salary is £12,000 per annum. Applications should be sent to the Director of the Research Fellowship, University of Southampton, Southampton, England. Closing date: 15th September 1978.

WALES THE UNIVERSITY UNIVERSITY COLLEGE OF SWANSEA

Applications are invited for the post of Lecturer in the Department of Swansea. The successful candidate will be required to undertake research in the field of Swansea, and to contribute to the development of the department. The post is full-time and permanent. Salary is £12,000 per annum. Applications should be sent to the Director of the Department of Swansea, University of Swansea, Swansea, Wales. Closing date: 15th September 1978.

LECTURER Applications are invited for the post of Lecturer in the Department of Swansea. The successful candidate will be required to undertake research in the field of Swansea, and to contribute to the development of the department. The post is full-time and permanent. Salary is £12,000 per annum. Applications should be sent to the Director of the Department of Swansea, University of Swansea, Swansea, Wales. Closing date: 15th September 1978.

LECTURER

Applications are invited for the post of Lecturer in the Department of Swansea. The successful candidate will be required to undertake research in the field of Swansea, and to contribute to the development of the department. The post is full-time and permanent. Salary is £12,000 per annum. Applications should be sent to the Director of the Department of Swansea, University of Swansea, Swansea, Wales. Closing date: 15th September 1978.

LECTURER II, IN INORGANIC CHEMISTRY (Salary £3,278-£5,493) plus £312 p.a.

The successful applicant will be required to teach in the Department of Inorganic Chemistry. The post is full-time and permanent. Salary is £3,278-£5,493 plus £312 p.a. Applications should be sent to the Director of the Department of Inorganic Chemistry, University of Southampton, Southampton, England. Closing date: 15th September 1978.

PLYMOUTH POLYTECHNIC DRANGE CIRCUS PLYMOUTH PL4 8AA

LONDON THAMES POLYTECHNIC SCHOOL OF SURVEYING

Applications are invited for the post of Lecturer in the School of Surveying. The successful candidate will be required to undertake research in the field of surveying, and to contribute to the development of the school. The post is full-time and permanent. Salary is £12,000 per annum. Applications should be sent to the Director of the School of Surveying, Thames Polytechnic, London. Closing date: 15th September 1978.

Leeds POLYTECHNIC

School of Constructional Studies

Applications are invited for the post of Lecturer in Quantity Surveying. The successful candidate will be required to undertake research in the field of quantity surveying, and to contribute to the development of the school. The post is full-time and permanent. Salary is £12,000 per annum. Applications should be sent to the Director of the School of Constructional Studies, Leeds Polytechnic, Leeds. Closing date: 15th September 1978.

School of Creative Arts and Design

Applications are invited for the post of Lecturer in the School of Creative Arts and Design. The successful candidate will be required to undertake research in the field of creative arts and design, and to contribute to the development of the school. The post is full-time and permanent. Salary is £12,000 per annum. Applications should be sent to the Director of the School of Creative Arts and Design, Leeds Polytechnic, Leeds. Closing date: 15th September 1978.

School of Management and Business Studies

Applications are invited for the post of Lecturer in the School of Management and Business Studies. The successful candidate will be required to undertake research in the field of management and business studies, and to contribute to the development of the school. The post is full-time and permanent. Salary is £12,000 per annum. Applications should be sent to the Director of the School of Management and Business Studies, Leeds Polytechnic, Leeds. Closing date: 15th September 1978.

Details from: The Academic Officer (MA.13) Leeds Polytechnic Calverley Street Leeds LS1 3BE 0532 41101

RICHMOND COLLEGE HEAD OF DEPARTMENT of Fine Arts and Music

The College wishes to appoint a Head of Department to co-ordinate and develop courses in the History of Art, Studio Art & Music. The appointment, which is open to men and women, will be full-time and for one year in the first instance. Applicants should be graduates with considerable experience of administration at a senior level. Salary: £4,800.

Application forms and further information may be obtained from the Principal, Richmond College, Primers Stile Road, Richmond, Surrey. Applications should be returned as soon as possible.

DEPARTMENT OF VISUAL COMMUNICATION Principal Lecturer in Graphic Design

Applications are invited for the post of Principal Lecturer in Graphic Design to lead a proposed B.A. (Hons.) course in Information Graphics. Salary: £5,940-£8,642 (Bar)-£7,575 plus £312 per annum supplement. Further details and form of application from The Chief Administrative Officer, Trent Polytechnic, Burton Street, Nottingham NG1 4BU. Closing date 19th September, 1978.

TRENT POLYTECHNIC NOTTINGHAM

KINGSTON POLYTECHNIC School of Surveying WANTED!

1. CHARTERED QUANTITY SURVEYOR to teach mainly on degree-level courses in Quantity Surveying. A special interest in either Building Economics or Building Contract Law an advantage. 2. CHARTERED SURVEYOR to teach mainly on degree-level course in Estate Management. Principal subjects required: valuations and land use. Salary range Lecturer II/Senior Lecturer: £3,888-£7,025 inclusive of London allowances. Further details and application forms (to be returned by 30 September) from Appointments Officer, Kingston Polytechnic, Penrhyn Road, Kingston upon Thames KT1 2EE. 01-549 1366.

KINGSTON POLYTECHNIC School of Sociology Lecturer II/Senior Lecturer in SOCIAL WORK

required to join a team on a CQSW course for new entrants. Applicants must be qualified in social work (also, recently qualified persons considered) and have appropriate academic qualifications. A degree in one of the social sciences and an interest in child care or health would be an advantage. To commence 10th June. Salary range £3,581-£6,287 plus £297 London allowance. Further details and application forms (to be returned by 20 September) from Appointments Officer, Kingston Polytechnic, Penrhyn Road, Kingston upon Thames KT1 2EE. 01-549 1366.

CENTRAL LONDON THE POLYTECHNIC STUDENT ADVISER

To join the Student Services team in the Central London Polytechnic, a Student Adviser will be required to assist students with difficulties in their studies. The successful candidate will be required to undertake research in the field of student services, and to contribute to the development of the polytechnic. The post is full-time and permanent. Salary is £12,000 per annum. Applications should be sent to the Director of the Student Services, Central London Polytechnic, Central London. Closing date: 15th September 1978.

SHEFFIELD CITY POLYTECHNIC DEPARTMENT OF APPLIED SOCIAL SCIENCES TEMPORARY LECTURERSHIP IN MANAGEMENT (Two posts)

Applications are invited for the post of Temporary Lecturer in Management. The successful candidate will be required to undertake research in the field of management, and to contribute to the development of the department. The post is full-time and permanent. Salary is £12,000 per annum. Applications should be sent to the Director of the Department of Applied Social Sciences, Sheffield City Polytechnic, Sheffield. Closing date: 15th September 1978.

Colleges of Further Education London College of Fashion

Head of Department in Clothing Technology (Grade V)

Salary in accordance with the Burnham (FE) Report in the range £8,109-£8,673 (incl. of London Allowance).

This post is the most senior position in Specialist College in this subject in the U.K.

ilea Details and forms of application return within 14 days from the appearance of advertisement from The Senior Administrative Officer, 107 Curtain Road, EC2A 3DP.

Liverpool CENTRAL LIVERPOOL COLLEGE OF FURTHER EDUCATION VICE-PRINCIPAL (GROUP 5)

Applications are invited from suitably qualified persons for the above post. Duties to commence as soon as possible. Further details and application forms from the Director of Education, Education Offices, 14 St Thomas Street, Liverpool, L1 6BL. Closing date: 18th September, 1978.

THE TIMES HIGHER EDUCATION SUPPLEMENT 1978

Administration

NEWCASTLE UPON TYNE POLYTECHNIC CHIEF ADMINISTRATIVE OFFICER'S DEPARTMENT ADMINISTRATIVE OFFICER (£4,239-£4,992 plus £312 salary supplement)

Responsible to the Chief Administrative Officer for general and business administration, the provision of administrative services, and administration relative to Catering and other Central Services. Previous responsible administrative experience, preferably in connection with Further/Higher Education, required and appropriate professional qualification and/or degree preferred.

NJC Salary and Conditions (SO1/2)
For further particulars and application forms, returnable by Friday, 17th September, 1978, please send stamped addressed foolscap envelope to Staffing Officer, Newcastle upon Tyne Polytechnic, Ellison Building, Ellison Place, Newcastle upon Tyne NE1 8ST.

Re-advertisement LANCASHIRE COUNTY COUNCIL LANCASHIRE COLLEGE FOR ADULT EDUCATION Southport Road, Chorley PR7 1NB

VICE-PRINCIPAL (Burnham Vice-Principal Scale II: £6,387 p.a.)

We seek an energetic, active, imaginative and committed person, with experience in adult education innovation. Ability to work harmoniously with a small team is as important as the ability to make a full contribution to course initiation, design, teaching and experimentation in the wider field of Adult Education. Previous applications will be reconsidered. Further details and forms of application from the Principal. Closing date 20th September, 1978.

Colleges of Higher Education

Universities continued

CHESHIRE PARADE COLLEGE OF FURTHER EDUCATION Walsley Walsley

Handled for one year from September 1978. The successful candidate will be required to undertake research in the field of further education, and to contribute to the development of the college. The post is full-time and permanent. Salary is £12,000 per annum. Applications should be sent to the Director of the Parade College of Further Education, Walsley. Closing date: 15th September 1978.

BELFAST THE QUEEN'S UNIVERSITY LECTURESHIP IN SOCIAL ANTHROPOLOGY

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Polytechnics continued

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Applications are invited for the post of Lecturer in the Department of Freeston. The successful candidate will be required to undertake research in the field of Freeston, and to contribute to the development of the polytechnic. The post is full-time and permanent. Salary is £12,000 per annum. Applications should be sent to the Director of the Department of Freeston, Freeston Polytechnic, Freeston. Closing date: 15th September 1978.

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